METRO (1989, 1990) describe intertidal and subtidal sediment sampling at three areas along the Seattle Waterfront in 1988 and 1989: the Northern Region near the old Union Oil fuel dock on Pier 71 and the area proposed for Denny Way CSO capping project in 1990; and Central and Southern Regions where development was planned and the site of the first capping project at the Washington State Ferry Terminal in 1989 (Figures 25-29). The ferry terminal and Denny Way capping projects are described. The report also has data on METRO sediment station LTDF01 which is sampled annually for priority pollutants (Figure 30)

METRO (1990) concludes "The highest sediment concentrations found in 1988 and 1989 were from the central waterfront, followed by areas to the south and north of the central waterfront. In the central and southern waterfront areas, the highest sediment chemistry values occurred at the shore end of the slips, with lower values near the mouth and even lower values farther offshore."

Monitoring of the Pier 53-55 cap and surrounding areas (Romberg 1993a,c) has shown that concentrations of metals and PAHs nearshore under the piers is higher than cleanup standards and are similar to (but in some cases higher than) the contamination present prior to placing the Pier 53-55 cap. In addition, sampling subsequent to a recent release of PAHs at the DOT ferry terminal shows that the area of the former wing wall is heavily contaminated with a creosote-like material and that nearby areas, including areas of the Pier 53-55 cap have been recontaminated above cleanup standards for PAHs by this material. The source of this material may have been numerous creosoted pilings or weathered material from a historic creosoting plant at this location.

Hart Crowser (1990) did a sediment quality assessment between Pier 62 and 66 for a marina development at Pier 64/65 by the Port of Seattle. They reviewed existing data (including unpublished Port of Seattle data not obtained for the present literature search), collected surface sediments and cores, and deployed sediment traps to assess the need for and general scope of sediment remediation. Figures 31-34 show sampling locations and contours for lead and PAH.

With regard to surface sediments, Hart Crowser concluded that no significant differences in contaminant concentrations existed alongshore within the study area (Pier 62 - 66); concentrations of lead and PAH declined with distance from shore indicating sources close to shore; and other chemicals such as mercury, zinc and PCBs did not vary with distance off shore indicating regional sources.

Vertical profiles were interpreted as showing that lead and zinc inputs have been slowly reducing over time, there was an abrupt reduction in PCB sources (highest concentrations of PCBs were found in the deepest samples; 40-50 cm), and existence of a PAH source close to the shoreline -- possibly from creosoted pilings and urban runoff.

Sumeri and Romberg (undated) describe the Denny Way sediment capping project and include core data on zinc, mercury and fluoranthene (Figures 35, 36). Craig Homan provided selected figures (37 - 41) from an upcoming METRO report on the cap.

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Krone, *et al.*, (1988, 1989) report data on tributyltins at three stations along the Seattle Waterfront.

Weston (1993) report and map extensive sediment chemistry data from the Harbor Island remedial investigation, including sites along the mouth of the Duwamish River. Cubbage (1989) analyzed sediment chemistry at the mouth of the West Waterway as part of an investigation of PAH near the Wyckoff wood treatment plant. Data have also been collected by the Port of Seattle at Terminal 3 (unpublished). These results show highly contaminated areas of sediment surrounding Harbor Island, adjacent to Terminal 3, and offshore of the Wyckoff facility.

Sediments surrounding Harbor Island are characterized by high levels of cadmium, mercury, and tributyltin. PCBs also exceed cleanup standards over a large area, and are highest in East Waterway. Localized areas with high levels of antimony, arsenic, chromium, copper, lead, and zinc are found near the shipyards, including Terminal 3. Isolated areas with heavy petroleum contamination were found near certain CSOs and at the north end of Harbor Island. Contamination offshore of the Wyckoff facility is typical of the wood treating chemicals creosote and pentachlorophenol.

A number of additional references contain physical/chemical data on Elliott Bay sediments but are of limited use for the resuspension study because of location, small sample size, old information, or other reasons: Army Corps Engineers, *et al.*,, (1988a,b); Bates, *et al.*, (1979); Chapman, *et al.*, (1982, 1983); Cooper Consultants (1986); Evans-Hamilton Inc. (1988a,b); Gamponia, *et al.*, (1985); Harper-Owes (1983); NOAA (1988); Paulson, *et al.*, (1991a); PTI (1988, 1989); Striplin, *et al.*, (1991, 1992, 1993); Tatem and Johnson (1978); Tetra Tech (1990); and Varanasi, *et al.*, (1988).

<u>Conclusion</u>: Substantial amounts of recent data on sediment chemistry in the resuspension study area are contained in the reports by PTI and Tetra Tech (1988), METRO (1989, 1990) and Hart Crowser (1990).

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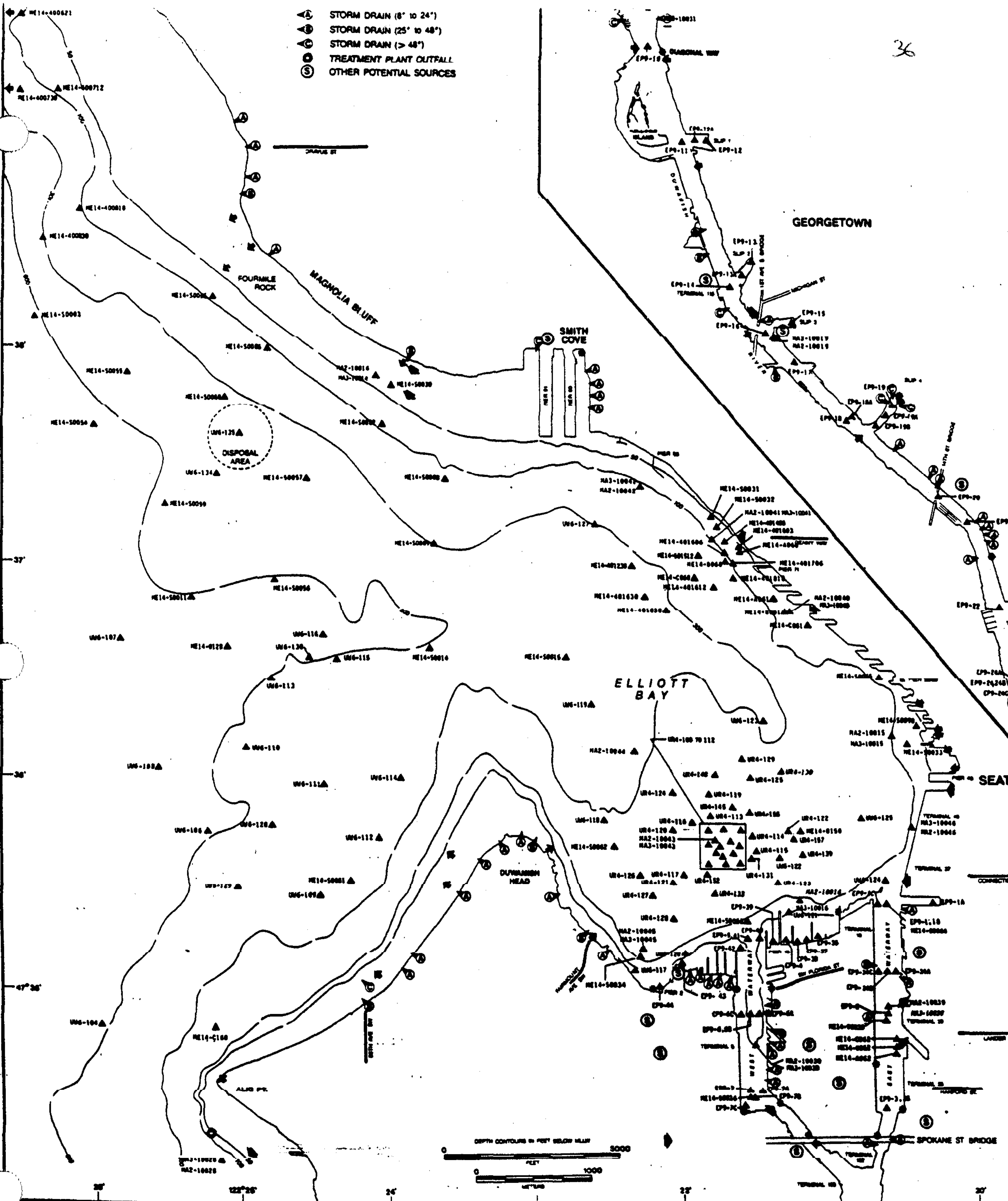


Sediment Chemistry: Sampling stations for selected data sets in Elliott Bay and the lower Duwamish River

▲ SAMPLING STATION

Figure 14. Tetra Tech (1986)

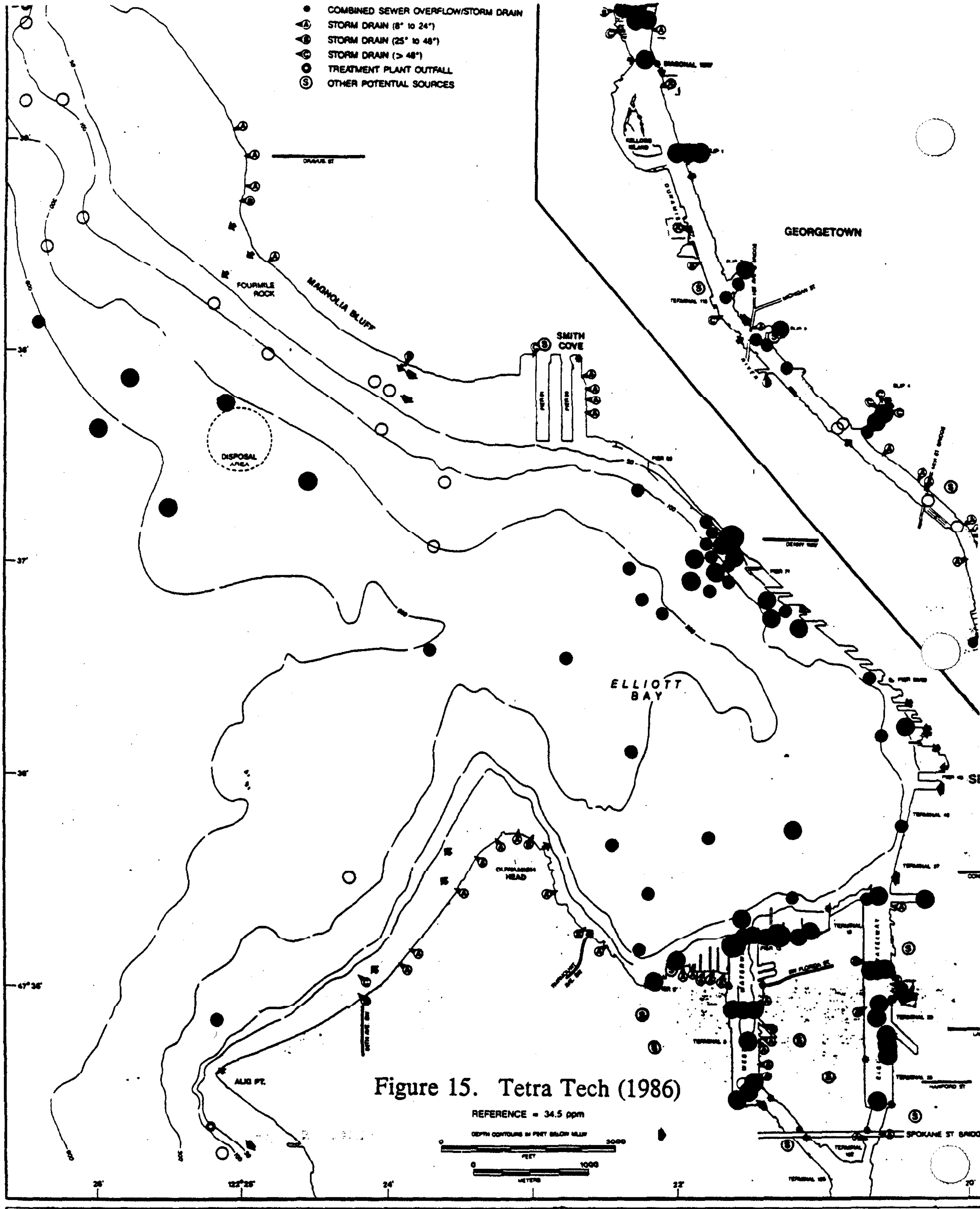
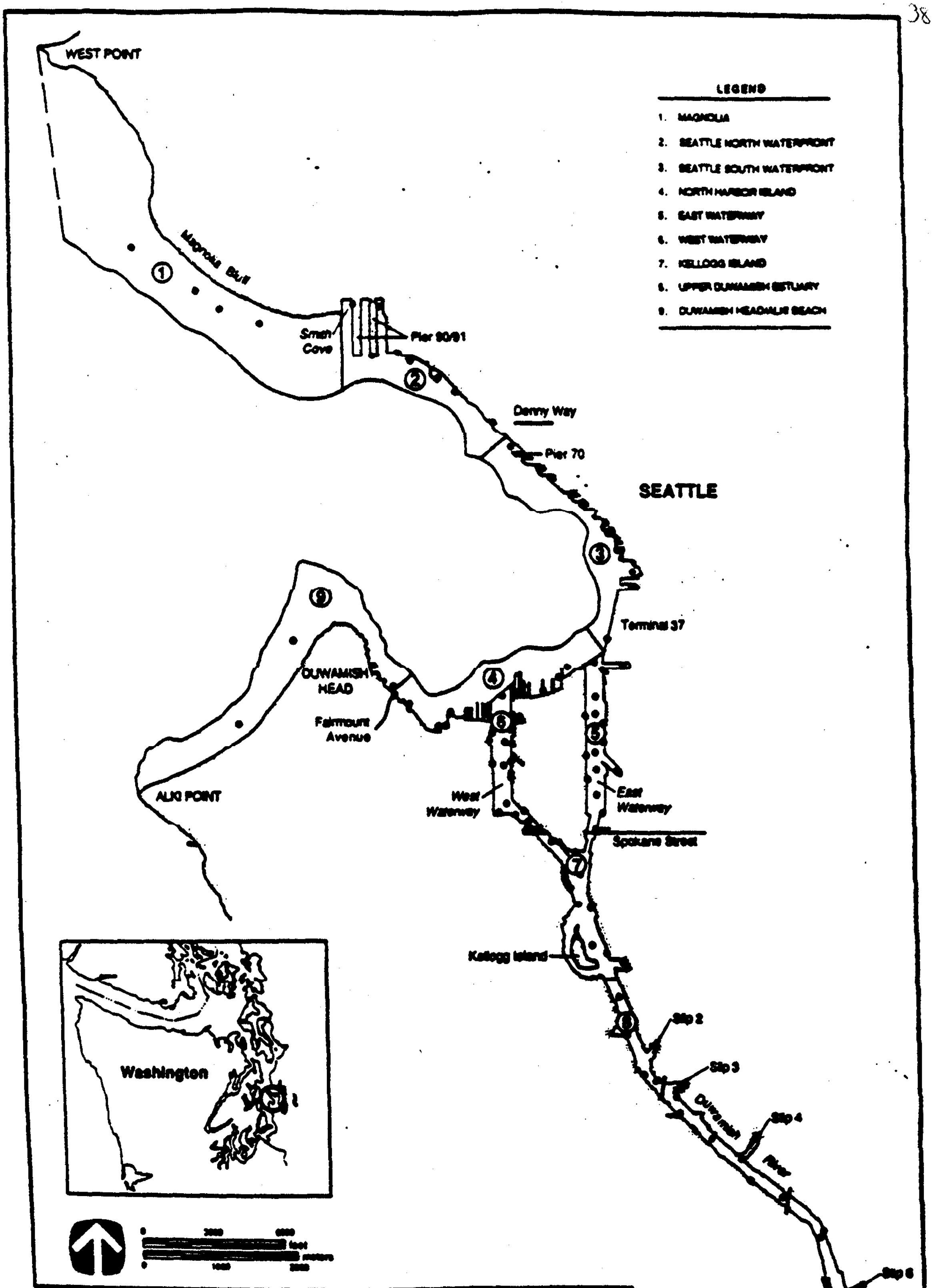


Figure 15. Tetra Tech (1986)

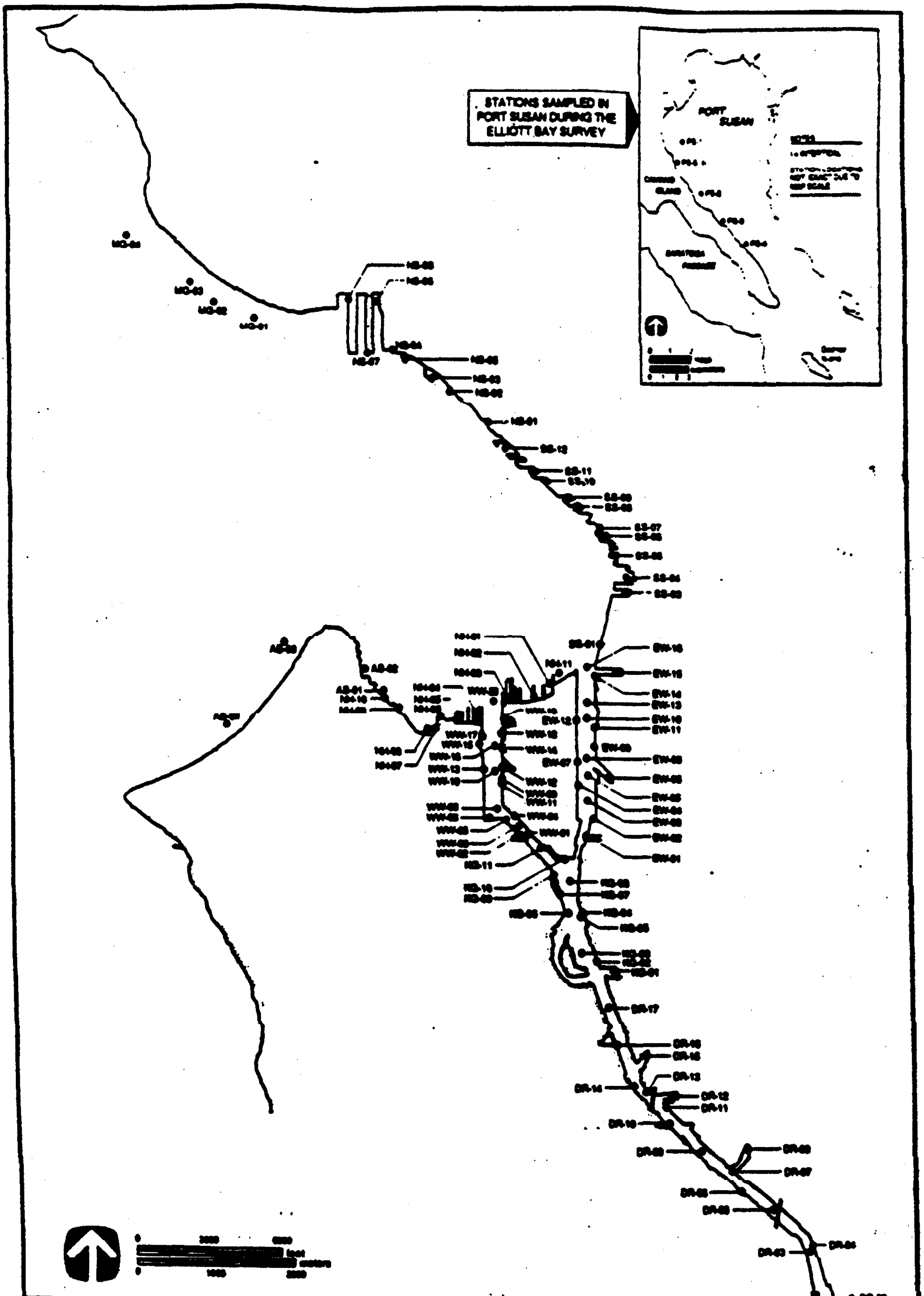
Sediment Chemistry: Elevations above reference for copper, lead, and zinc in Elliott Bay and the lower Duwamish River

- NOT SIGNIFICANT
- SIGNIFICANT, <10 X REFERENCE
- SIGNIFICANT, 10 - 100 X
- SIGNIFICANT, 100 - 1000 X
- SIGNIFICANT, >1000 X



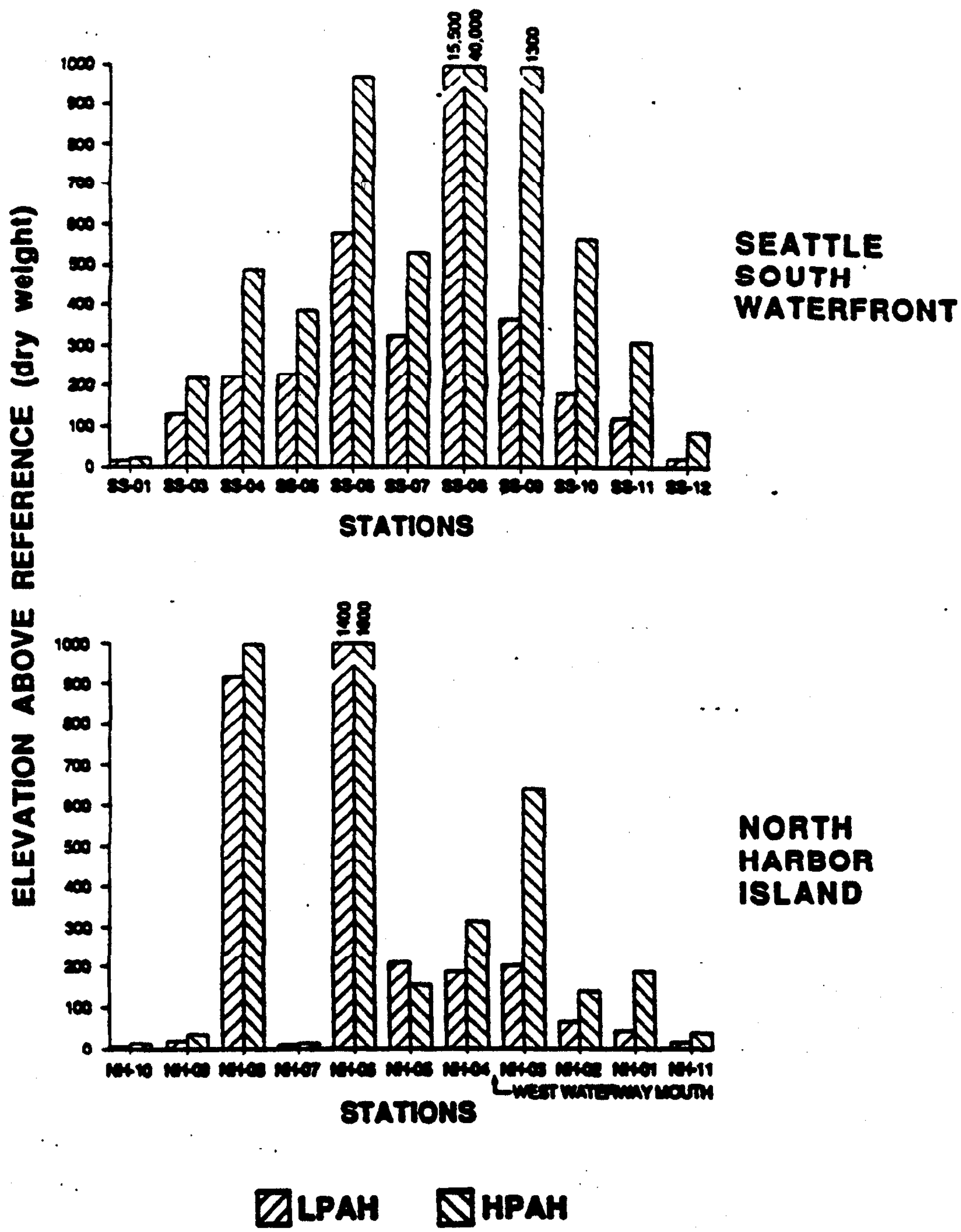
Project location and study areas within Elliott Bay and the lower Duwamish River.

Figure 16. Tetra Tech (1988)



Locations of sampling stations of sediment chemistry, amphipod bioassay, and benthic macroinvertebrates.

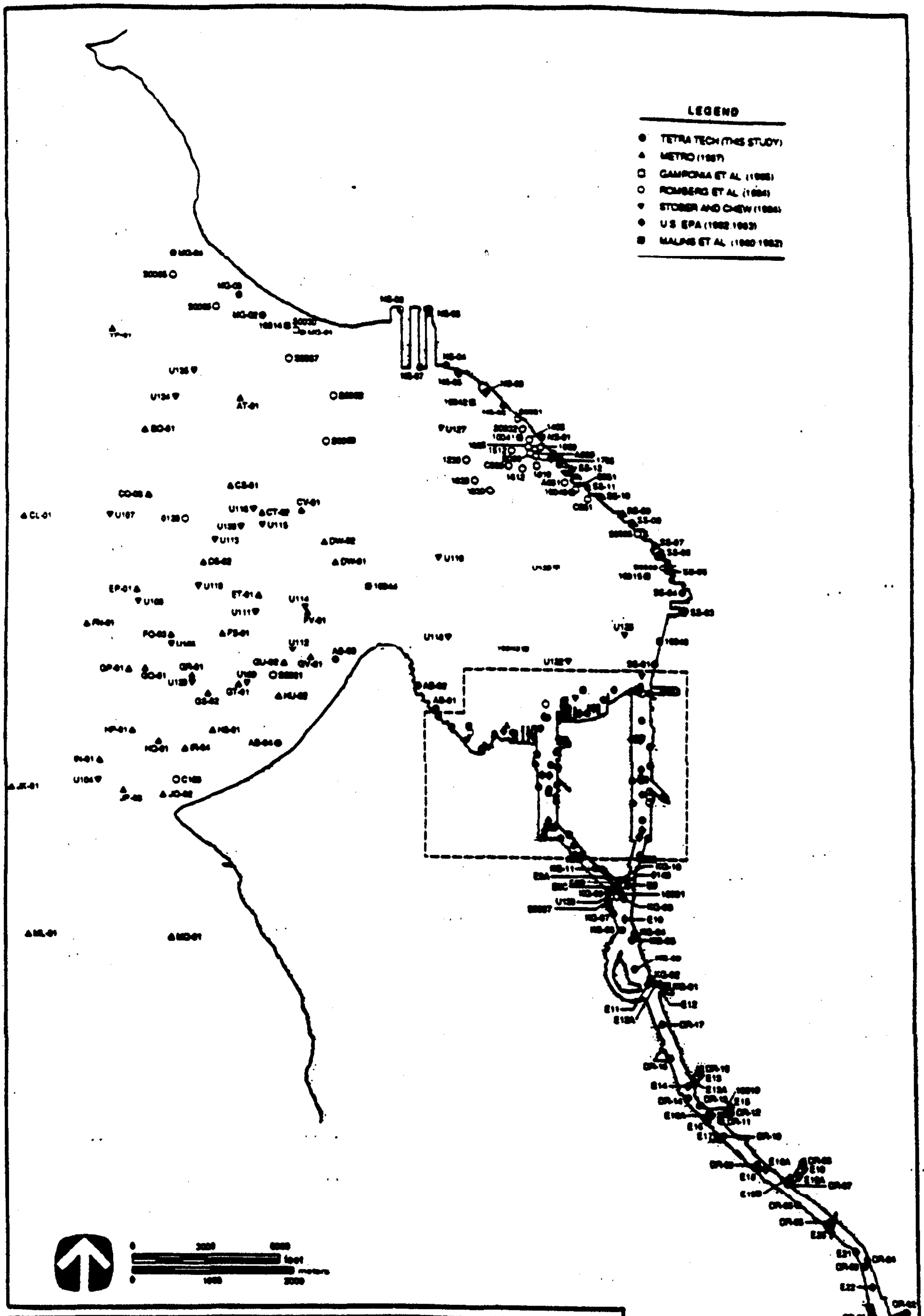
Figure 17. Tetra Tech (1988)



Carr Inlet Reference = 41 µg/kg DW (LPAH) and 79 µg/kg DW (HPAH).

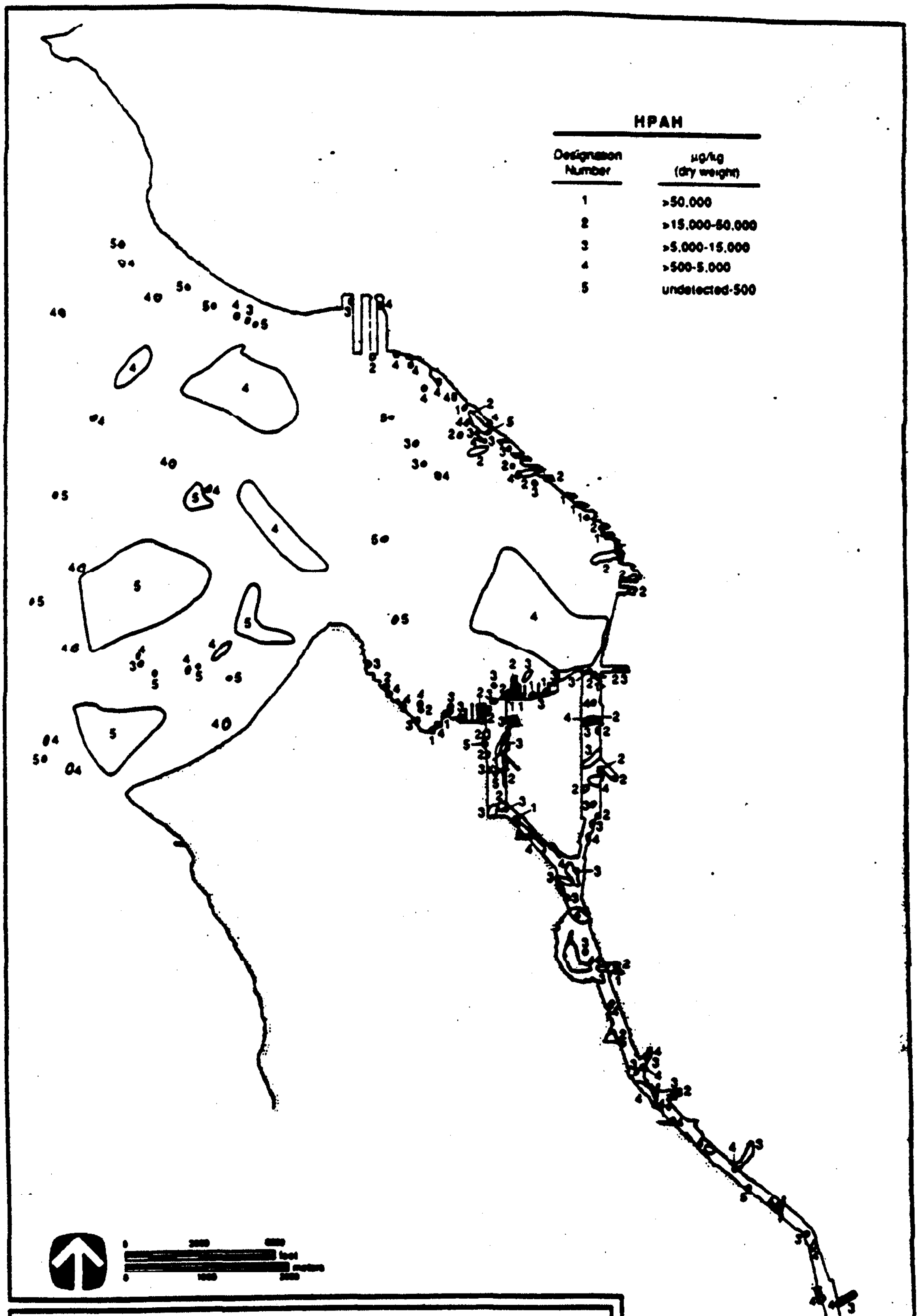
Elevations above reference (EAR) of LPAH and HPAH at individual stations in the most contaminated study areas.

Figure 18. Tetra Tech (1988)



Locations of sampling stations from historical studies of sediment chemistry in Elliott Bay and the Duwamish River.

Figure 19. Tetra Tech (1988)



Contours of HPAH concentrations in study area sediments.

Figure 20. Tetra Tech (1988)

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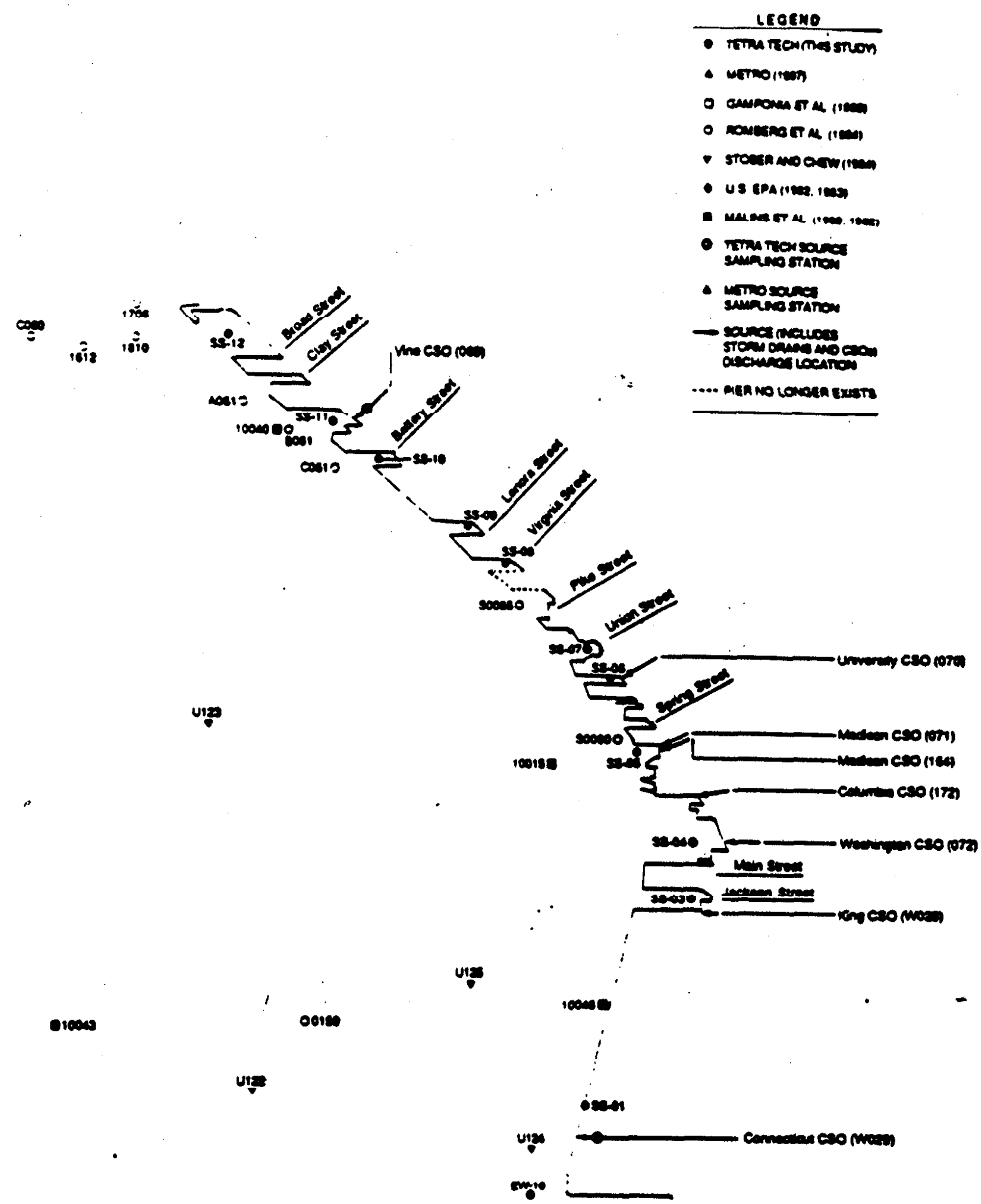


Figure 21. Tetra Tech (1988a)

Locations of offshore and drain sampling stations, CSOs, and storm drains in the Seattle South Waterfront study area.

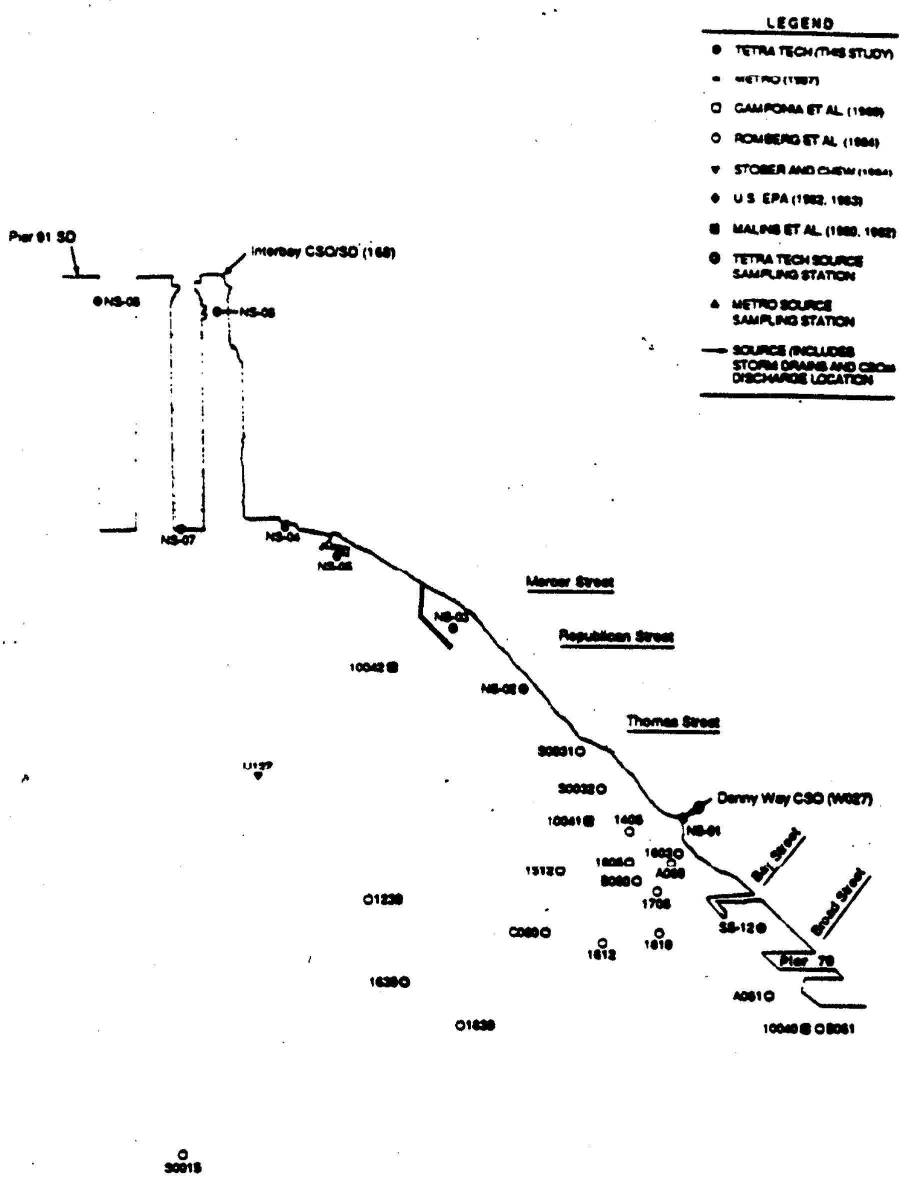
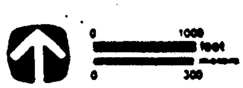
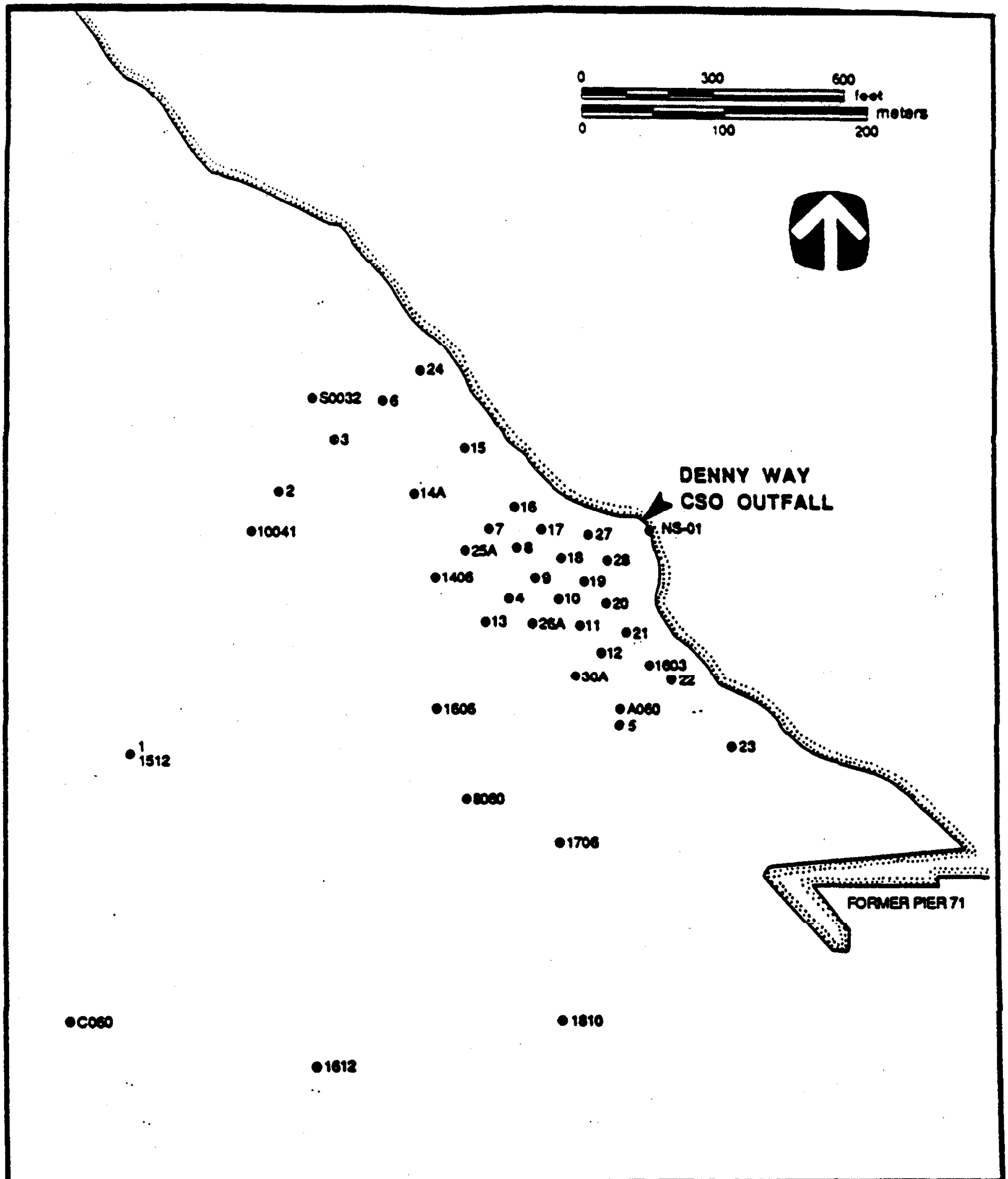


Figure 22. Tetra Tech (1988a)



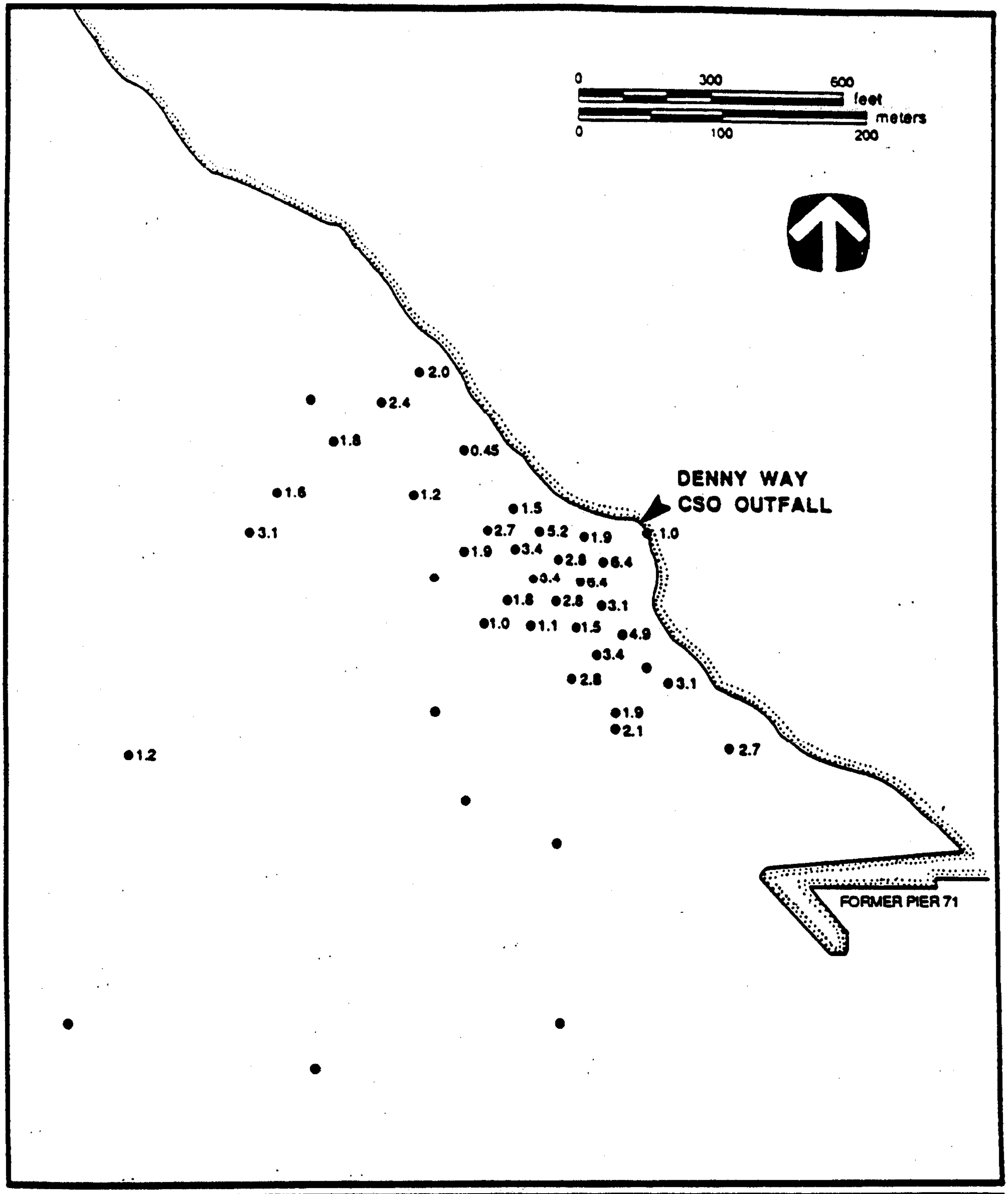
Locations of offshore and drain sampling stations, CSOs, and storm drains in the Seattle North Waterfront study area.

45



Sampling station locations in the Denny Way CSO problem area.

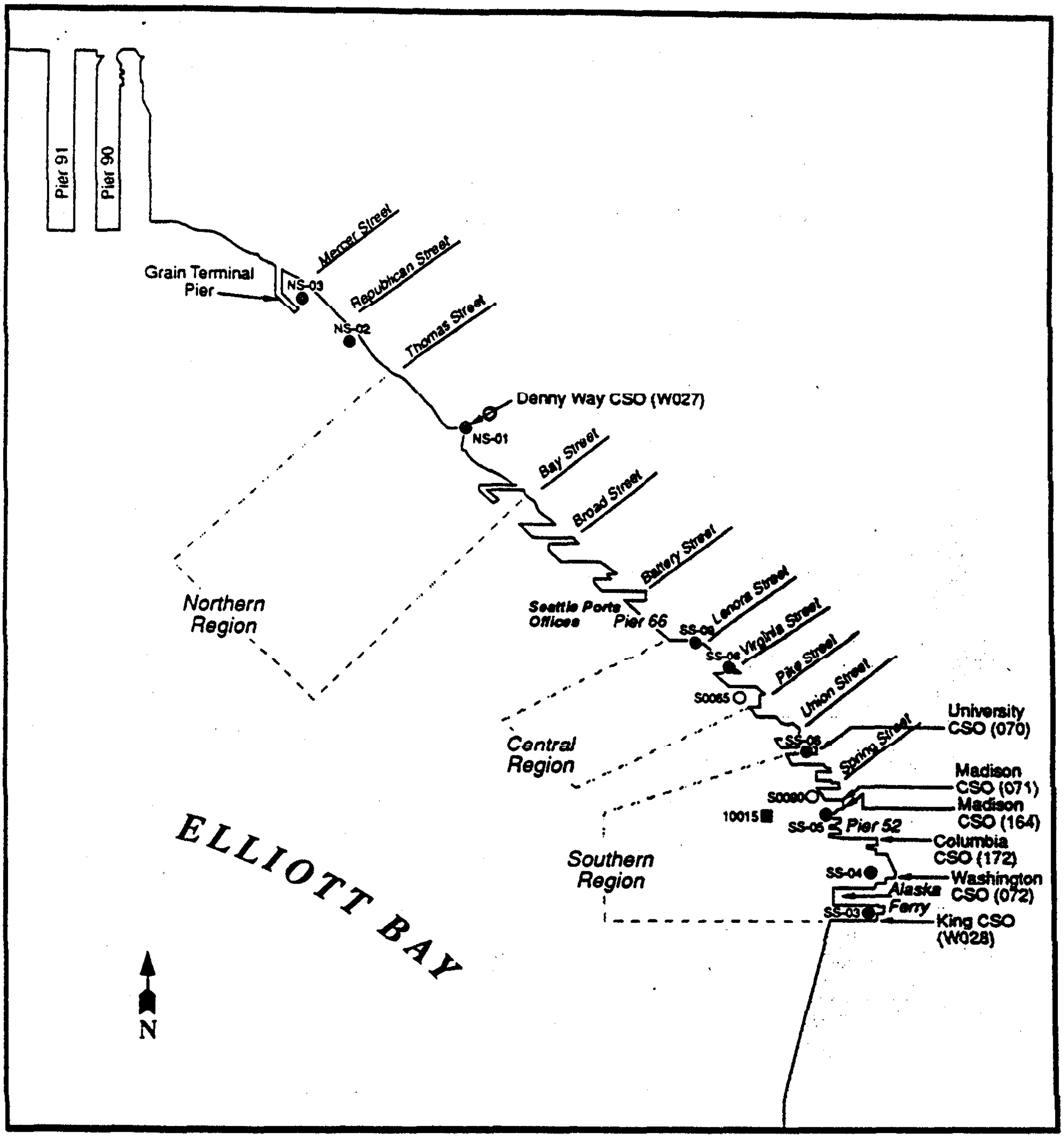
Figure 23. Tetra Tech (1988b)



Areal distribution of mercury concentrations in Denny Way surficial sediments, corrected for background concentration and normalized to the target cleanup goal (C_O'/C_G').

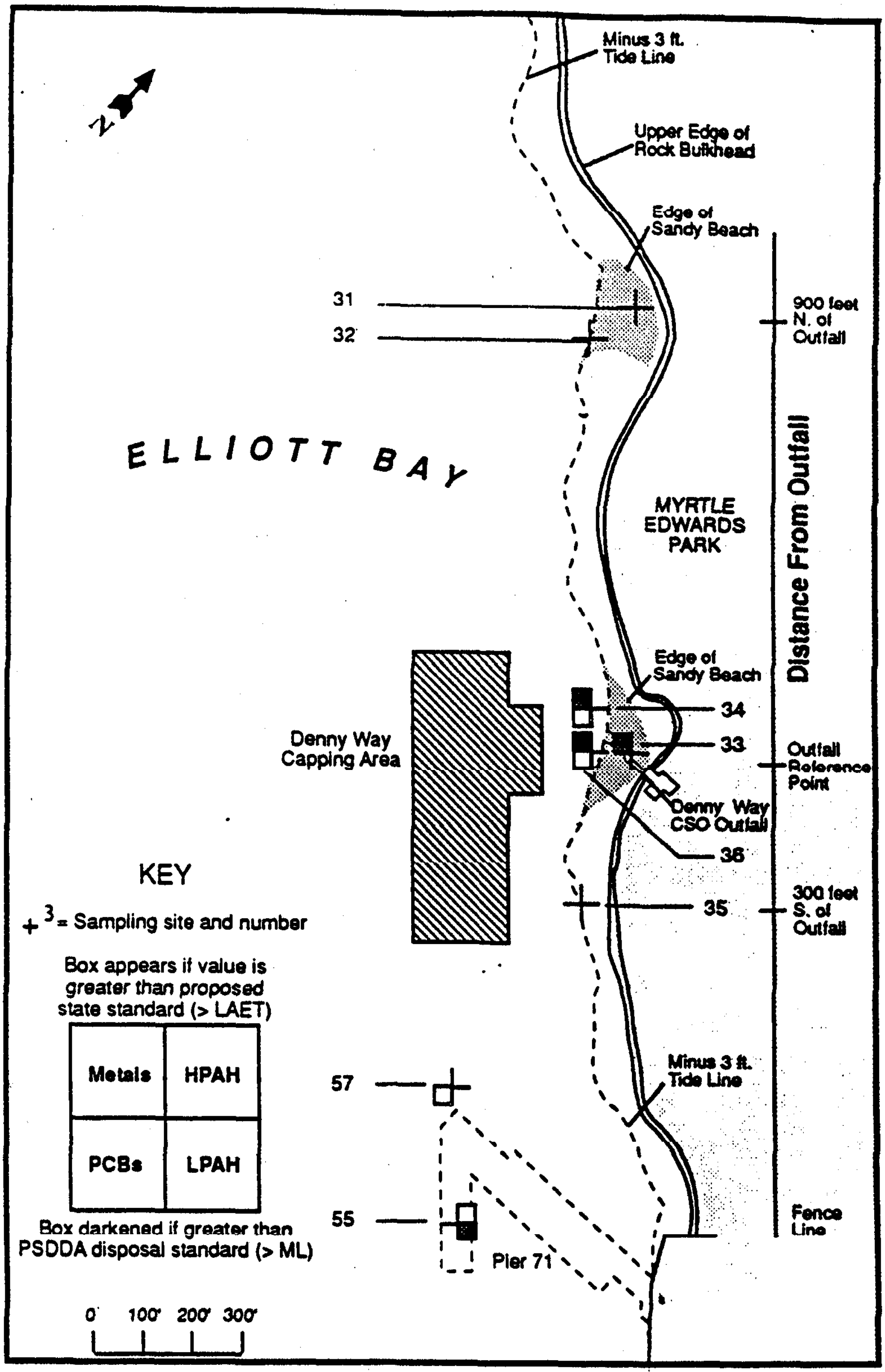
Figure 24. Tetra Tech (1988b)

47



Eastern Elliott Bay Shoreline Showing the Northern, Central, and Southern Regions Where Metro Collected Additional Sediment Samples in 1989

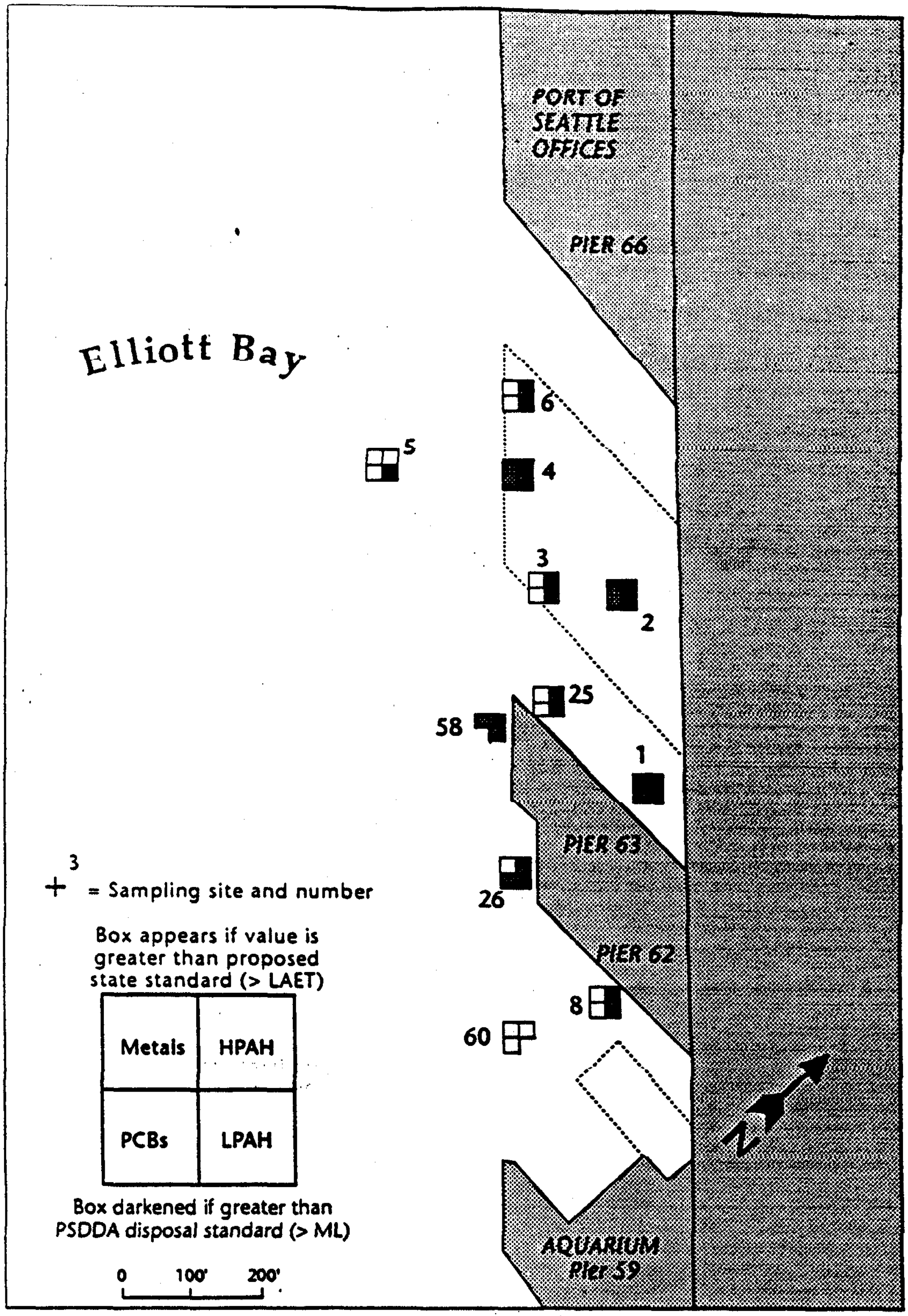
Figure 25. METRO (1989)



Northern Sampling Region, Illustrating Chemical Quality of Intertidal Sediments Collected at Sampling Sites 31 - 36 (sampled in 1988) and subtidal Sites 55 and 57 sampled in 1989

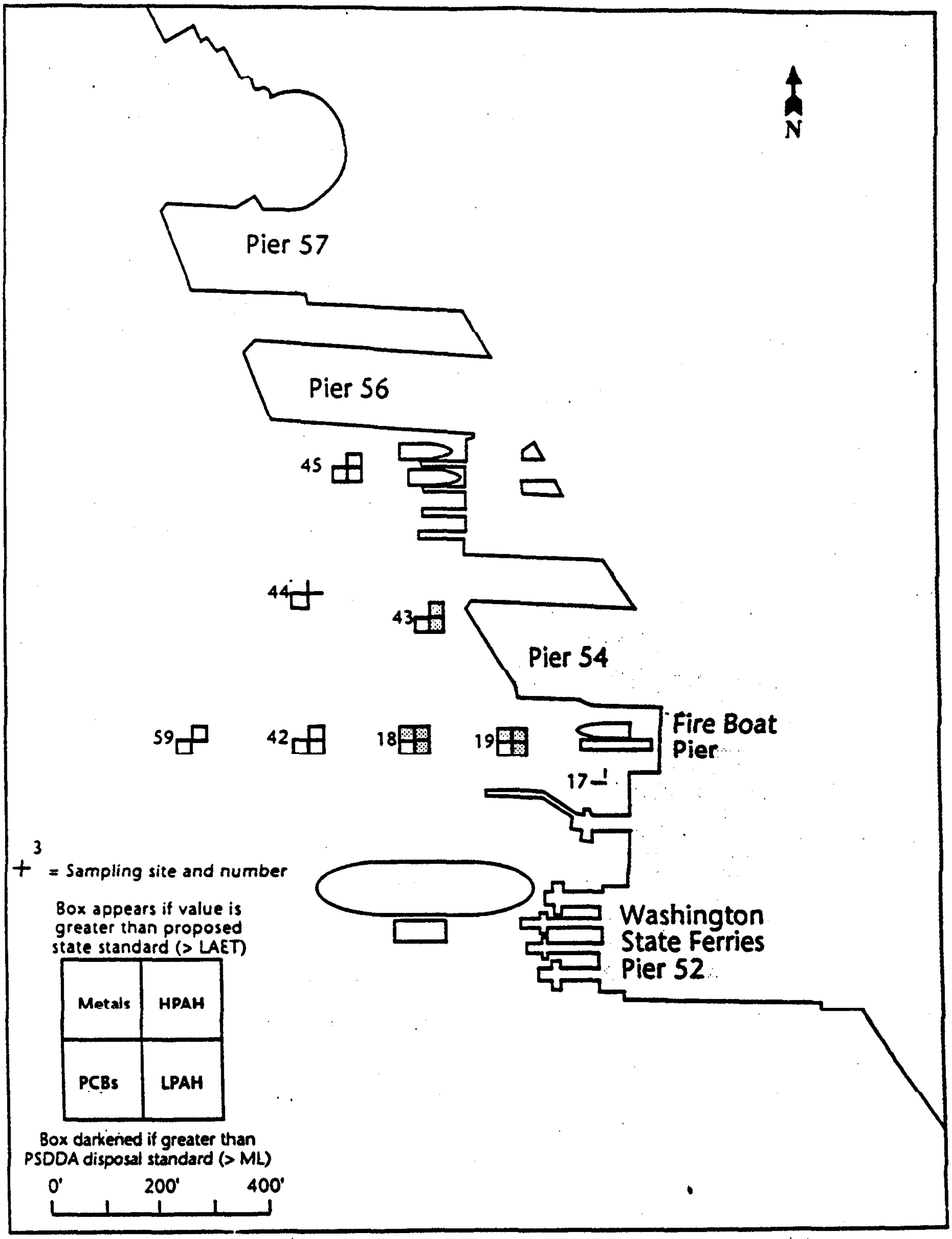
Figure 26. METRO (1989)

4 1



Central Sampling Area, Illustrating Chemical Quality of Subtidal Sediments Collected at Sampling Sites 1 - 6, 8, 25, 26 (sampled in 1988) and 58 and 60 (sampled in 1989)

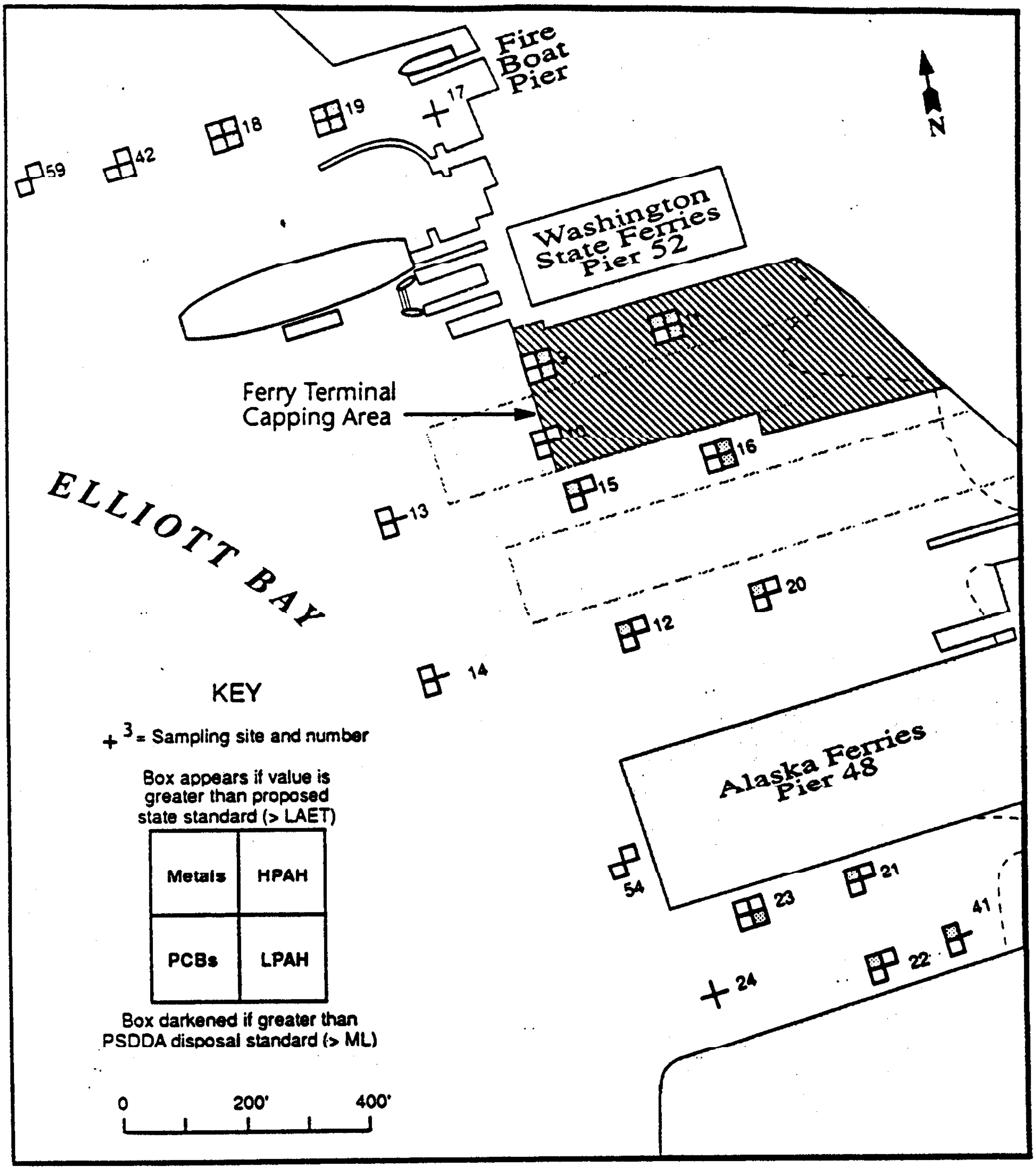
Figure 27. METRO (1989)



Southern Sampling Region, Illustrating Chemical Quality of Subtidal Sediments Collected at Sampling Sites 17 - 19 (sampled in 1988) and 42 - 45, and 59 (sampled in 1989)

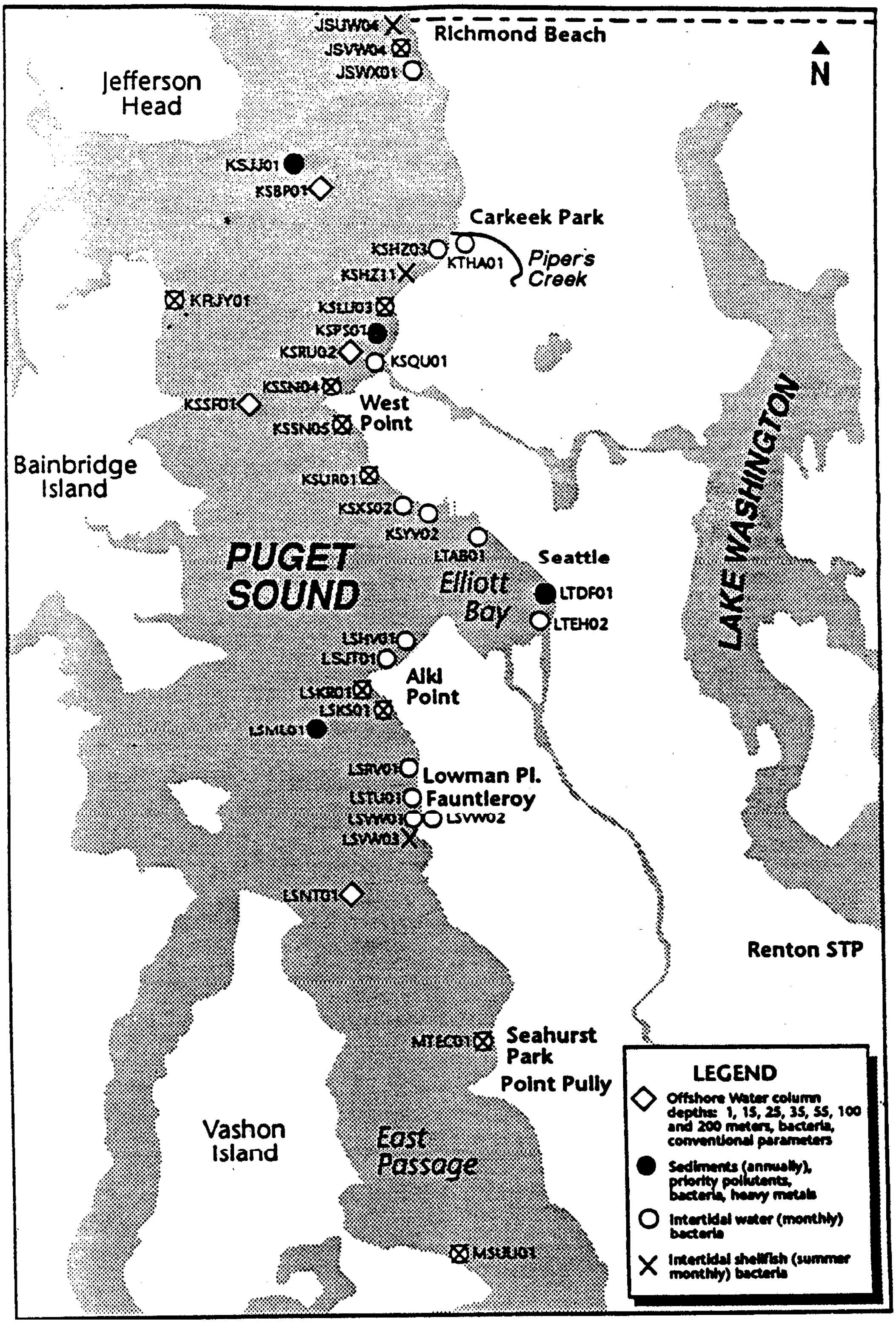
Figure 28. METRO (1989)

51



Southern Sampling Region, Illustrating Chemical Quality of Subtidal Sediments Collected at Sampling Sites 9 - 24 (sampled in 1988) and 41 and 54 (sampled in 1989)

Figure 29. METRO (1989)



Metro's Puget Sound Ambient Monitoring Program

Figure 30. METRO (1989)

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Site and Exploration Plan

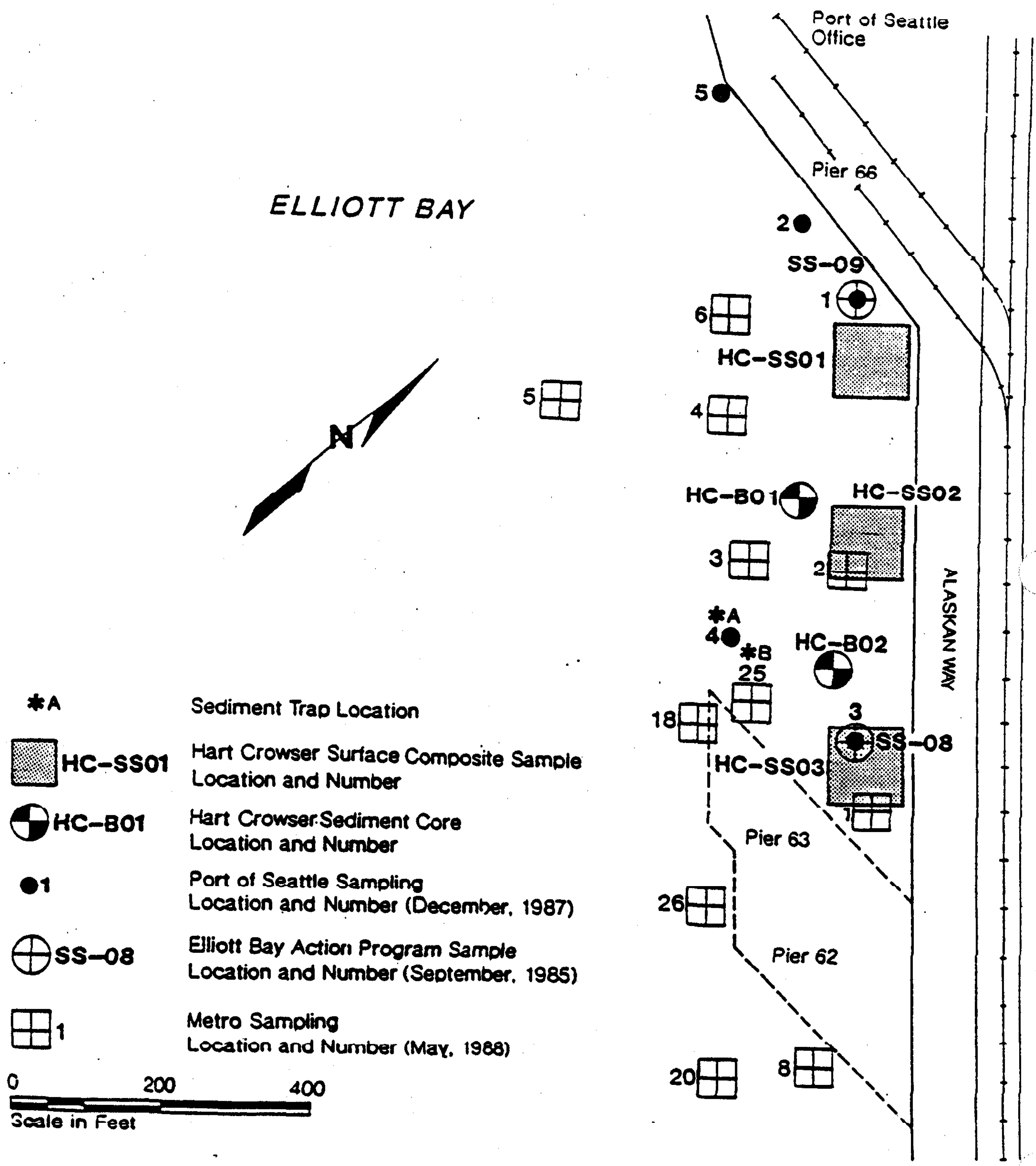

Figure 31. Hart Crowser (1990)

Surficial HPAH: TOC Concentrations Contour Map

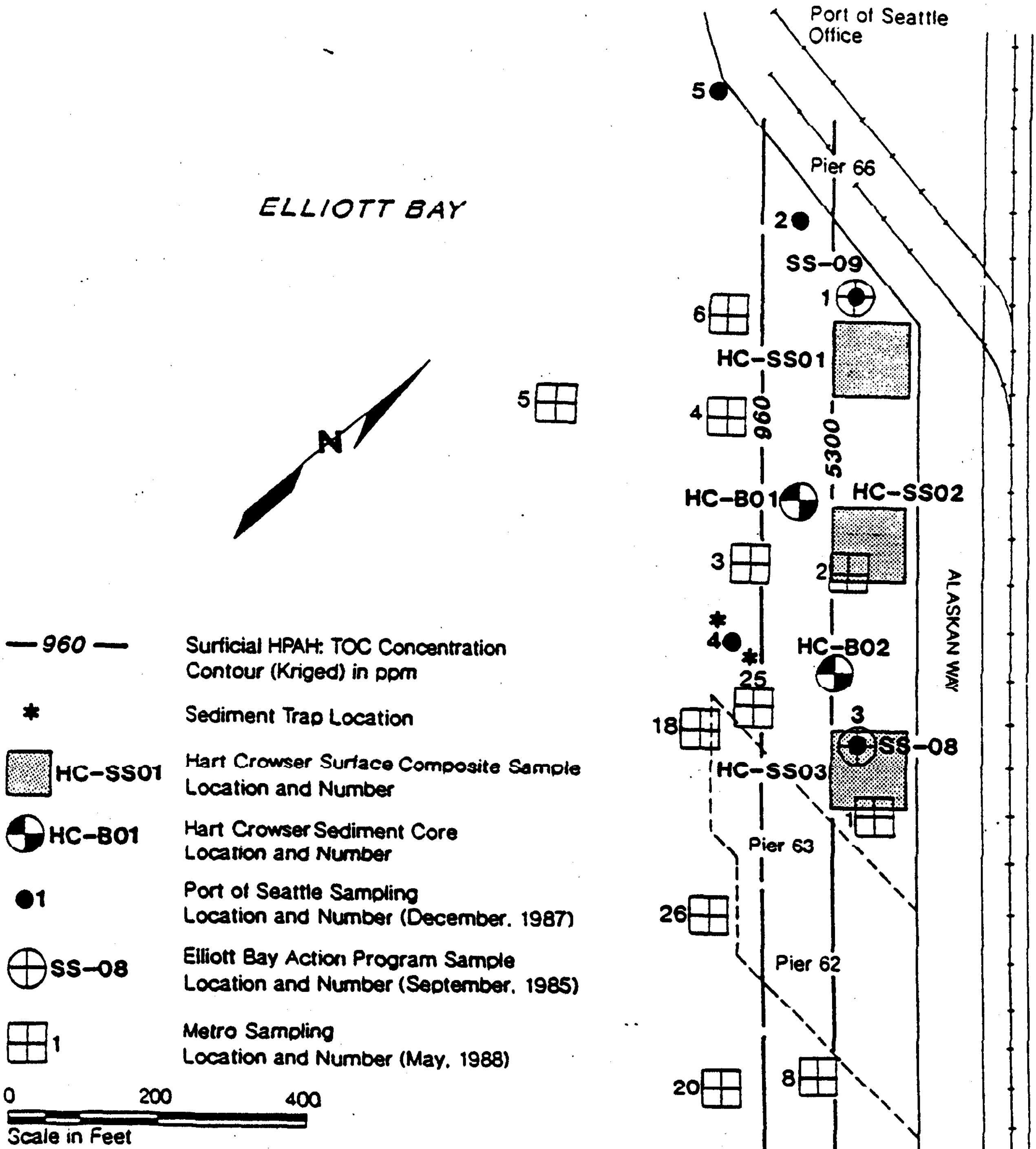

Figure 32. Hart Crowser (1990)

55

Surficial LPAH: TOC Concentrations Contour Map

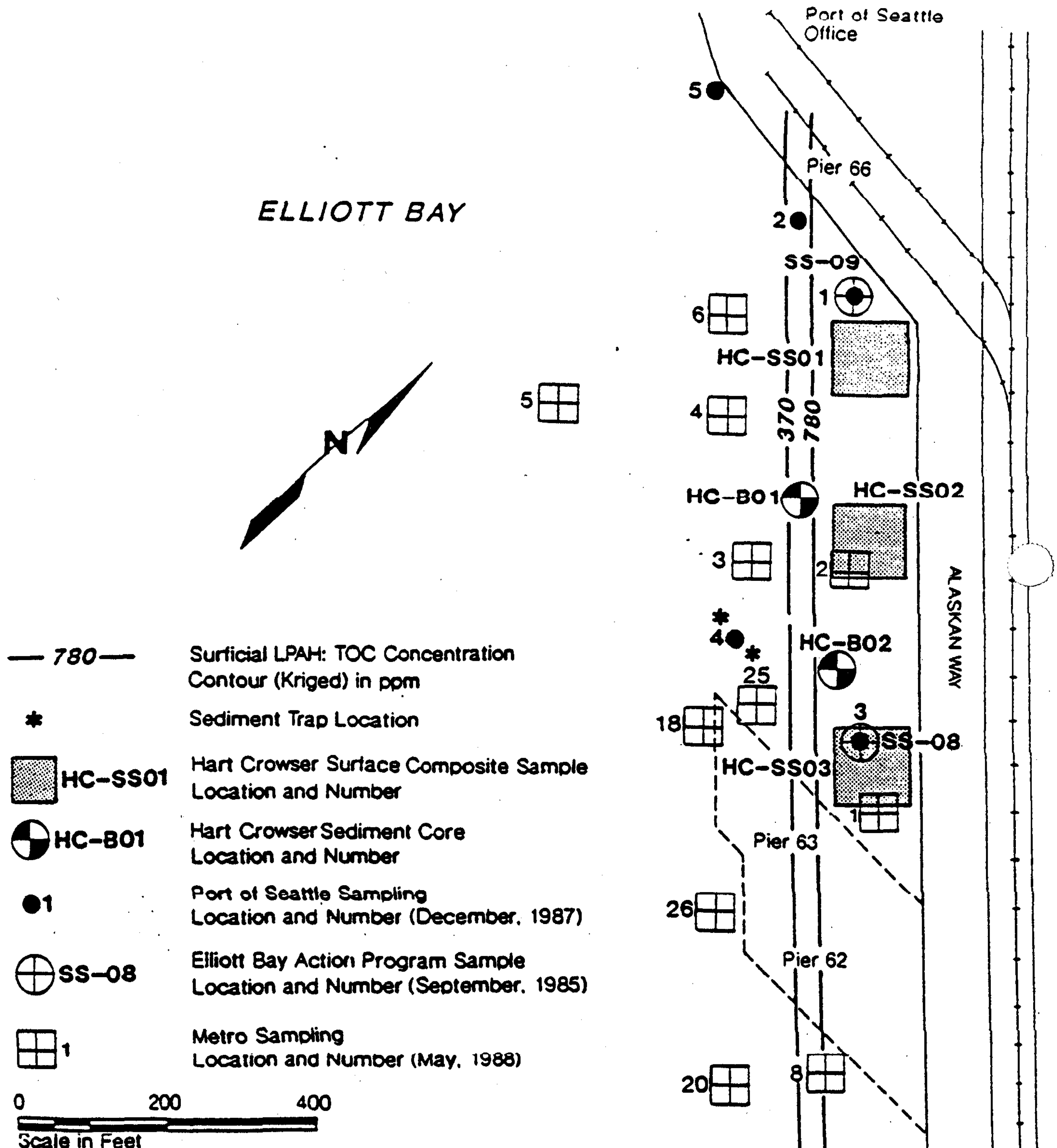

Figure 33. Hart Crowser (1990)

Surficial Lead Concentrations Contour Map

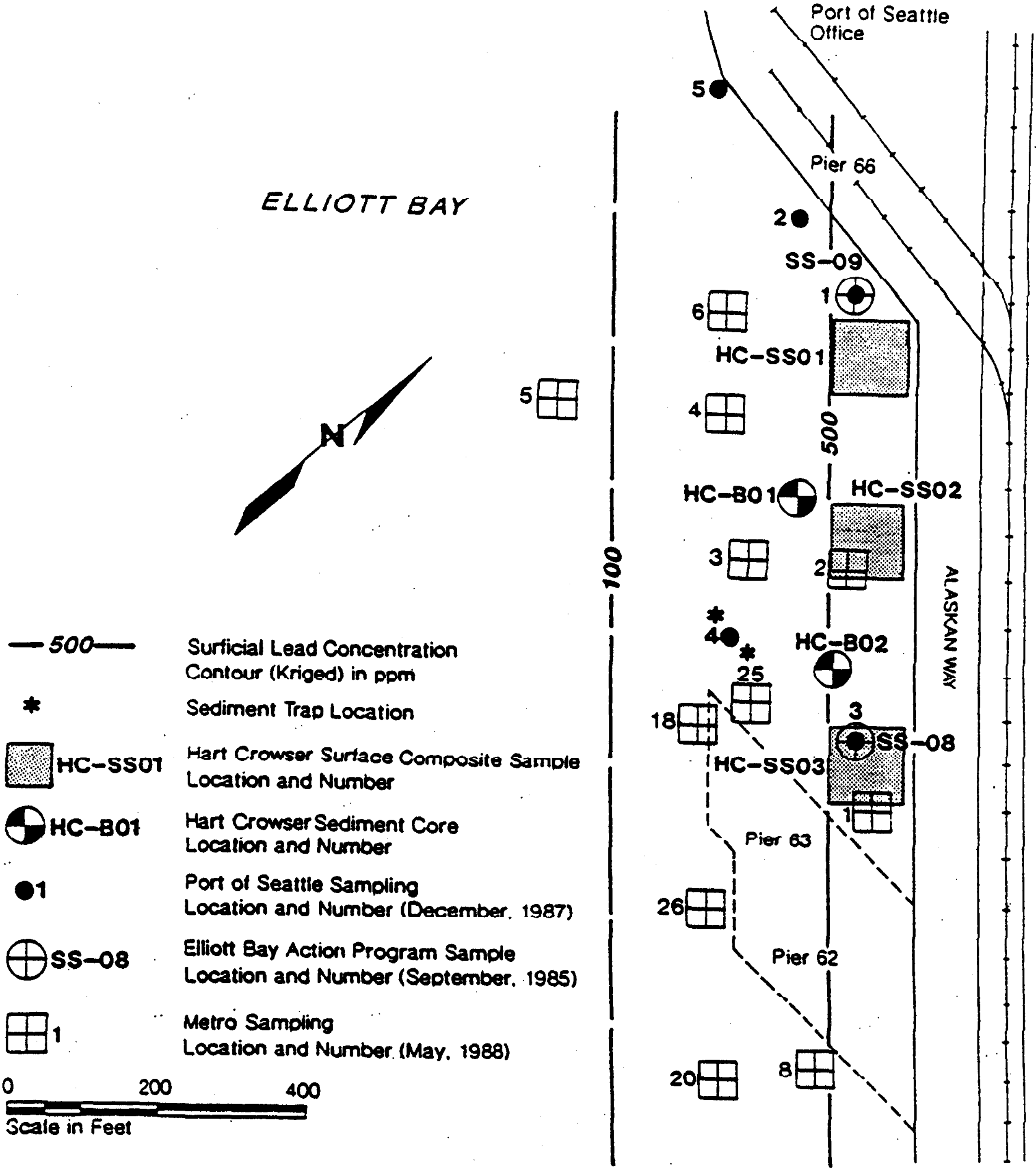

Figure 34. Hart Crowser (1990)

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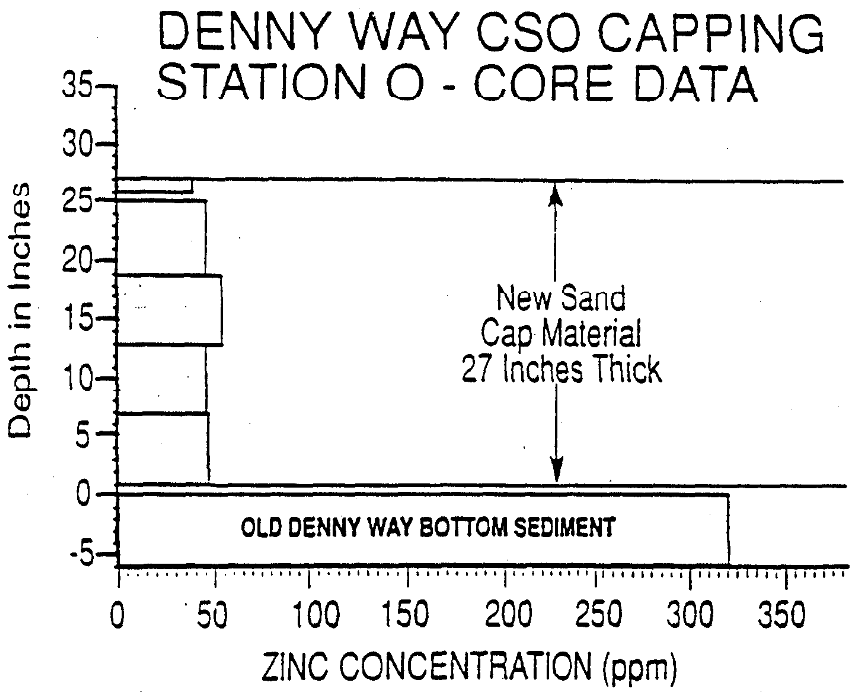


Zinc Sediment Concentrations at Station O

Figure 35. Sumeri & Romberg (undated)

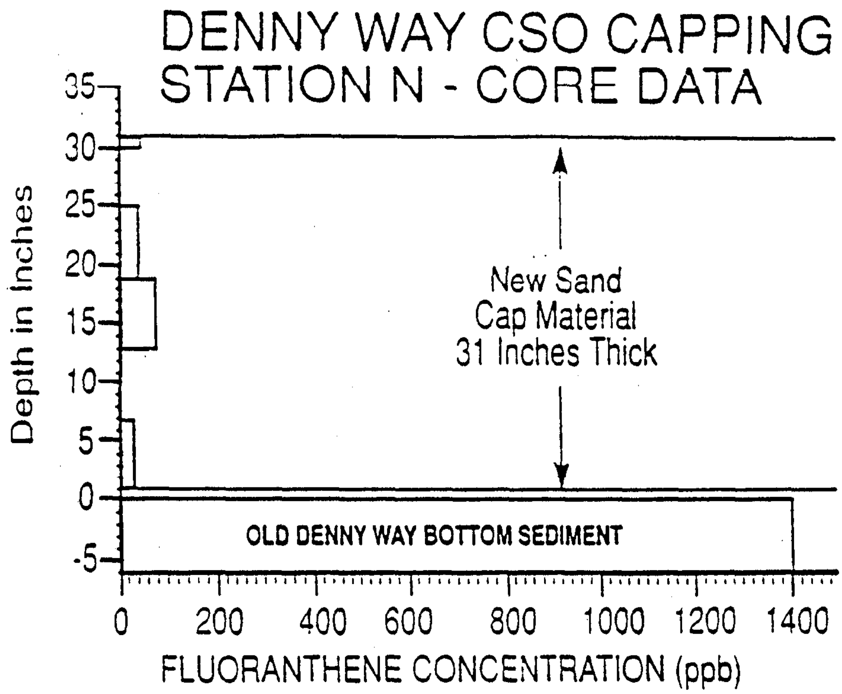
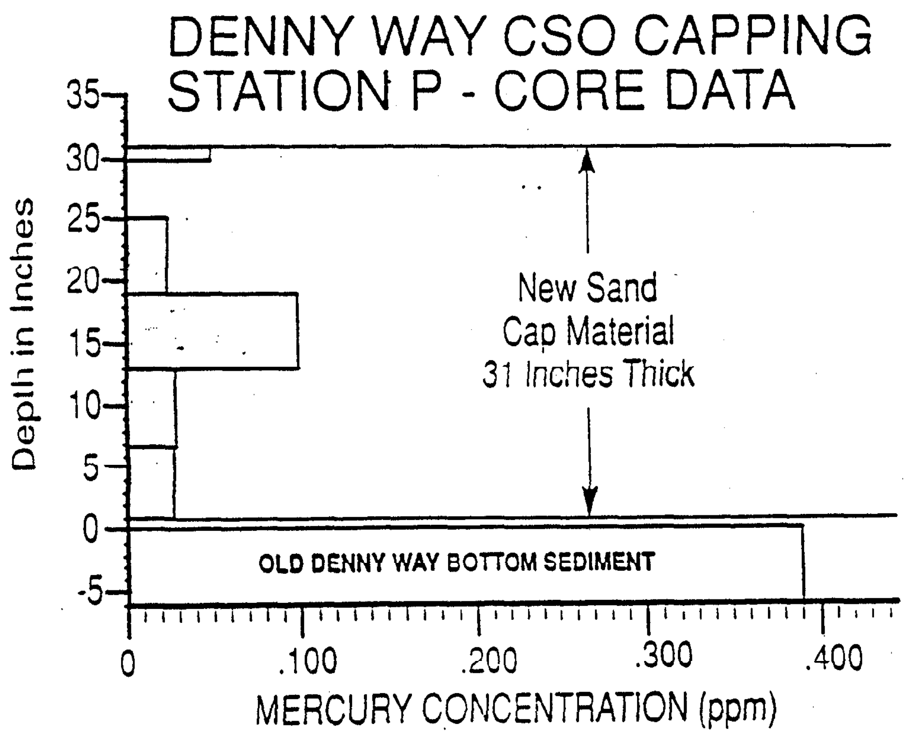


Figure 11. Fluoranthene Sediment Concentrations at Station N



Mercury Sediment Concentrations at Station P

Figure 36. Sumeri & Romberg (undated)

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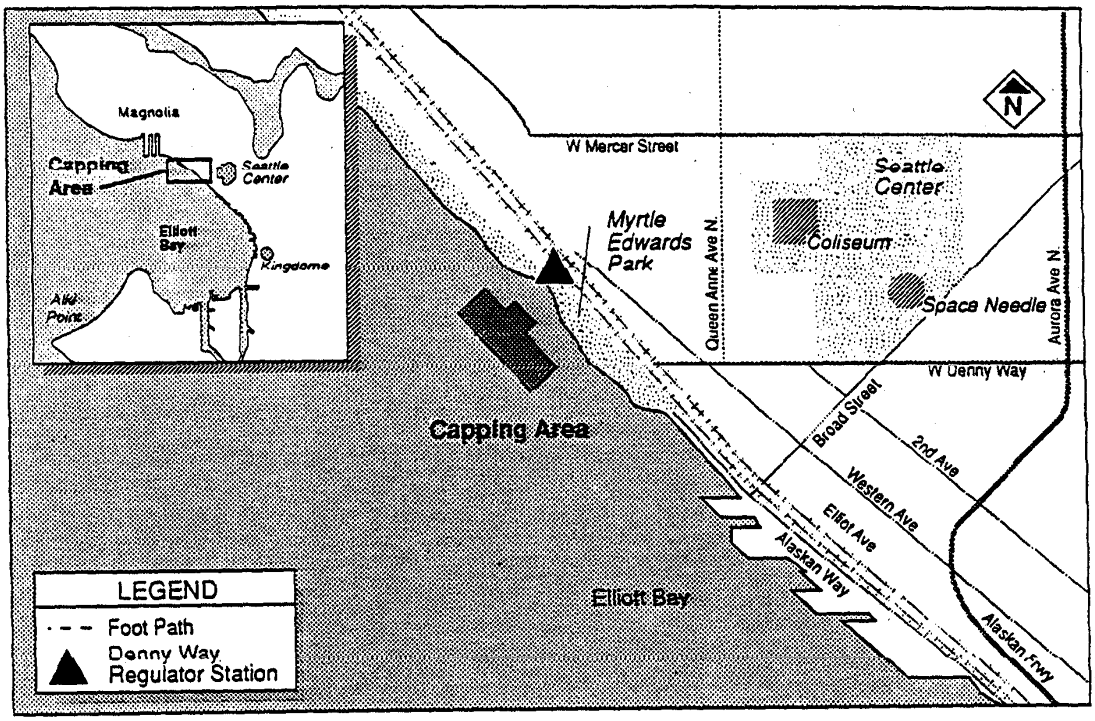

Figure 37. METRO unpublished

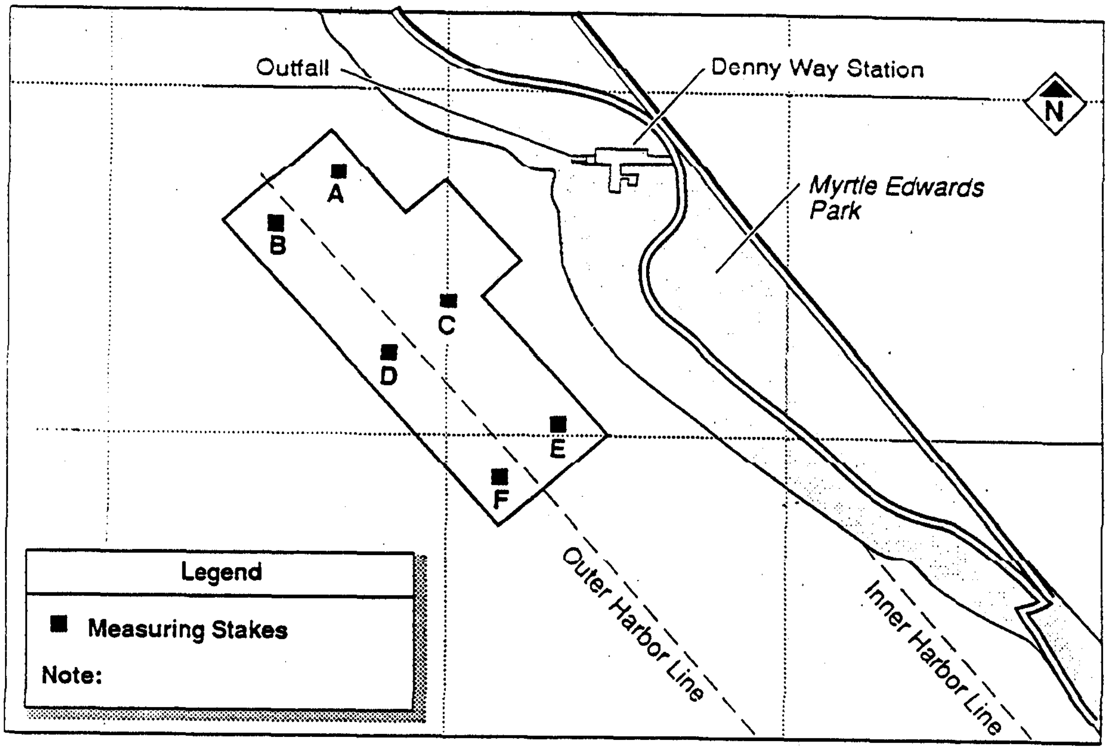

Figure 38. METRO unpublished

61

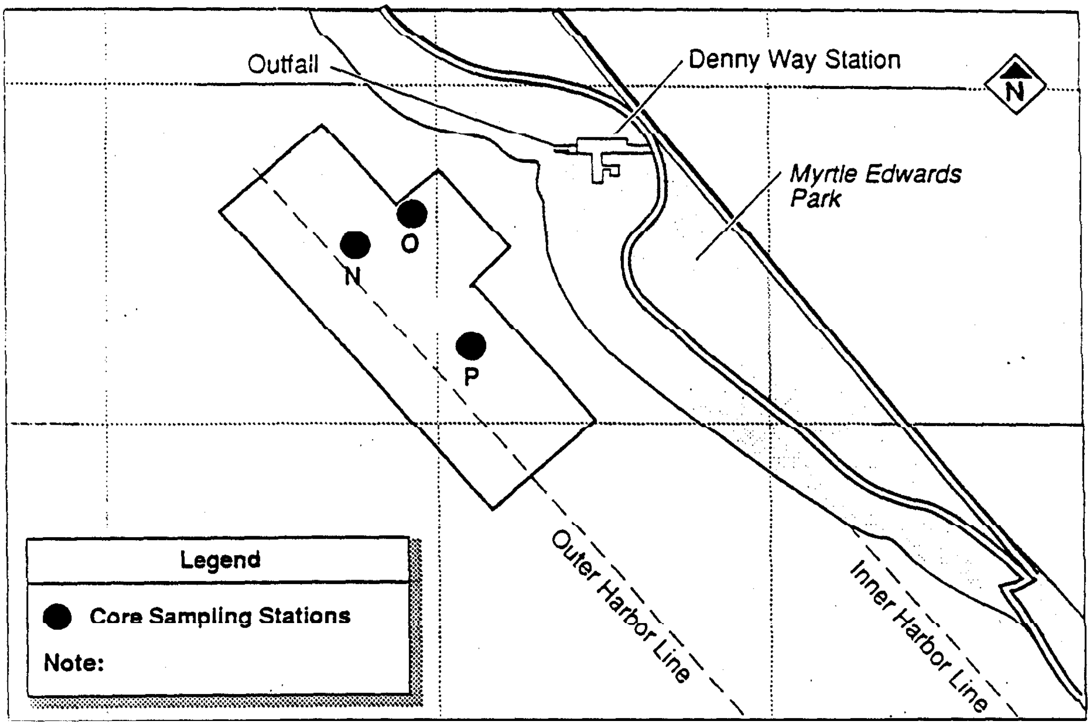

Figure 39. METRO unpublished

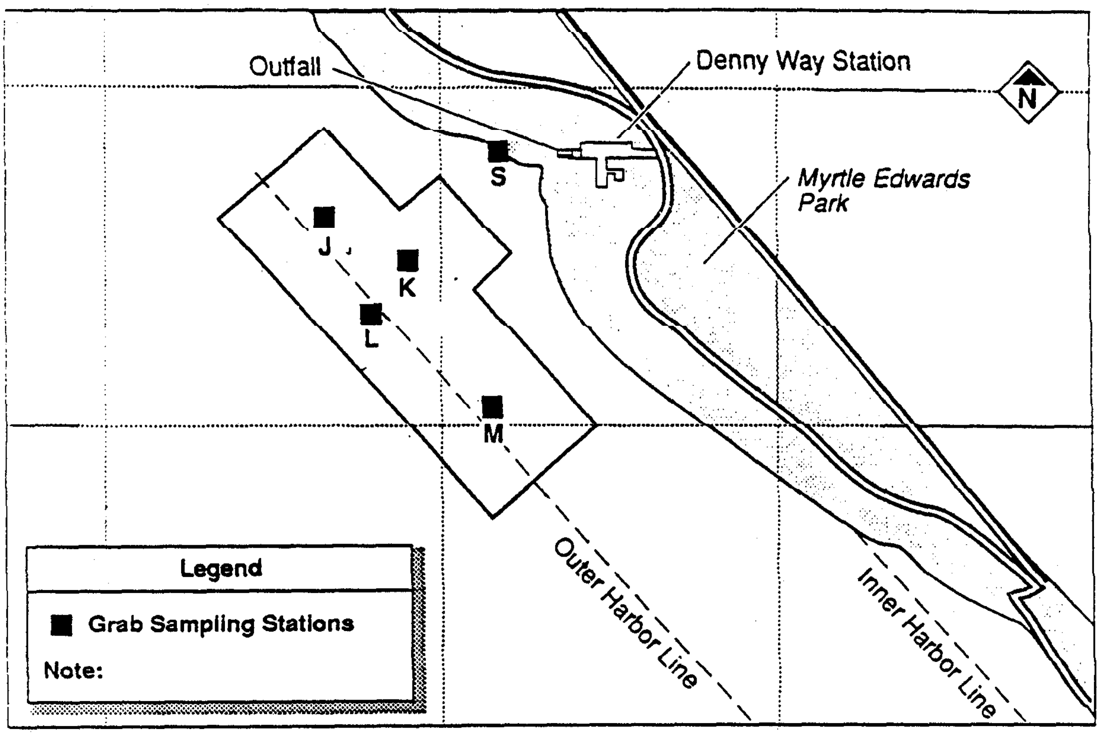

Figure 40. METRO unpublished

63

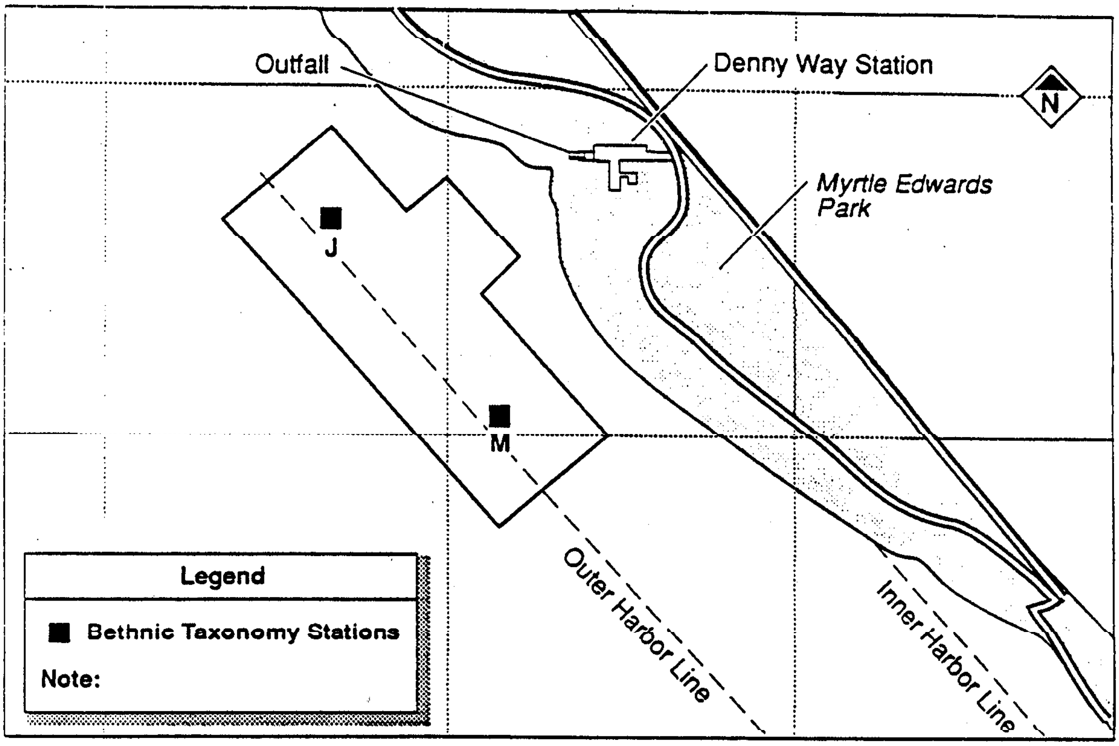

Figure 41. METRO unpublished

V. SEDIMENT TRAP STUDIES

Most Useful References: 3, 4, 18, 19, 32, 36, 57, 59

Other References: 7, 17, 22, 30, 61

Synopsis of Information Found: The only instance of sediment trap use along the Seattle waterfront was found in the Hart Crowser (1990) study. They deployed two traps 0.75m off the bottom 100 ft. north of Pier 63 during May 2 - July 10, 1990 (see Figure 31 in Bottom Sediment Surveys Section). Chemical analysis of the particulates in the trap showed mercury, LPAH and high molecular weight PAH (HPAH) exceeded Ecology draft sediment quality guidelines (Table 6).

NOAA had sediment traps in the deeper waters of the bay during 1979, 1980 and 1985 in studies already mentioned above. Baker (1982) and Baker, *et al.*, (1983) contain the results from moorings 2 and 4 (see Figure 1 in Section 1) that operated August-September 1979 and February-March 1980. Chemical analysis was limited to organic carbon.

During 1985, NOAA had traps at the station south of Pier 90; Paulson, *et al.*, (1991a) contains location and metals data (Figure 42; Tables 7 and 8). Paulson, *et al.*, (1989) and Feely, *et al.*, (1988) use these data to calculate vertical fluxes of metals. Curl, *et al.*, (1987) report concentrations of PAH, DDT compounds, and PCBs (see Figure 13 in Section 3 and Table 9).

Other sediment trap data for the main basin outside Elliott Bay are reported in Dexter, *et al.*, (1981), Curl (1982), Bates, *et al.*, (1984), Feely, *et al.*, (1986), and Paulson, *et al.* (1991c).

Conclusion: Limited sediment trap data was found for the study area, these being the two Hart Crowser (1990) deployments. These sediment trap data indicated the potential for recontamination along the waterfront from area-wide sources, but may also have been influenced by resuspension of local sediments (see Section VII).

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Summary of Selected Sediment Trap and Surficial Sediment Chemical Data - Pier 64/65

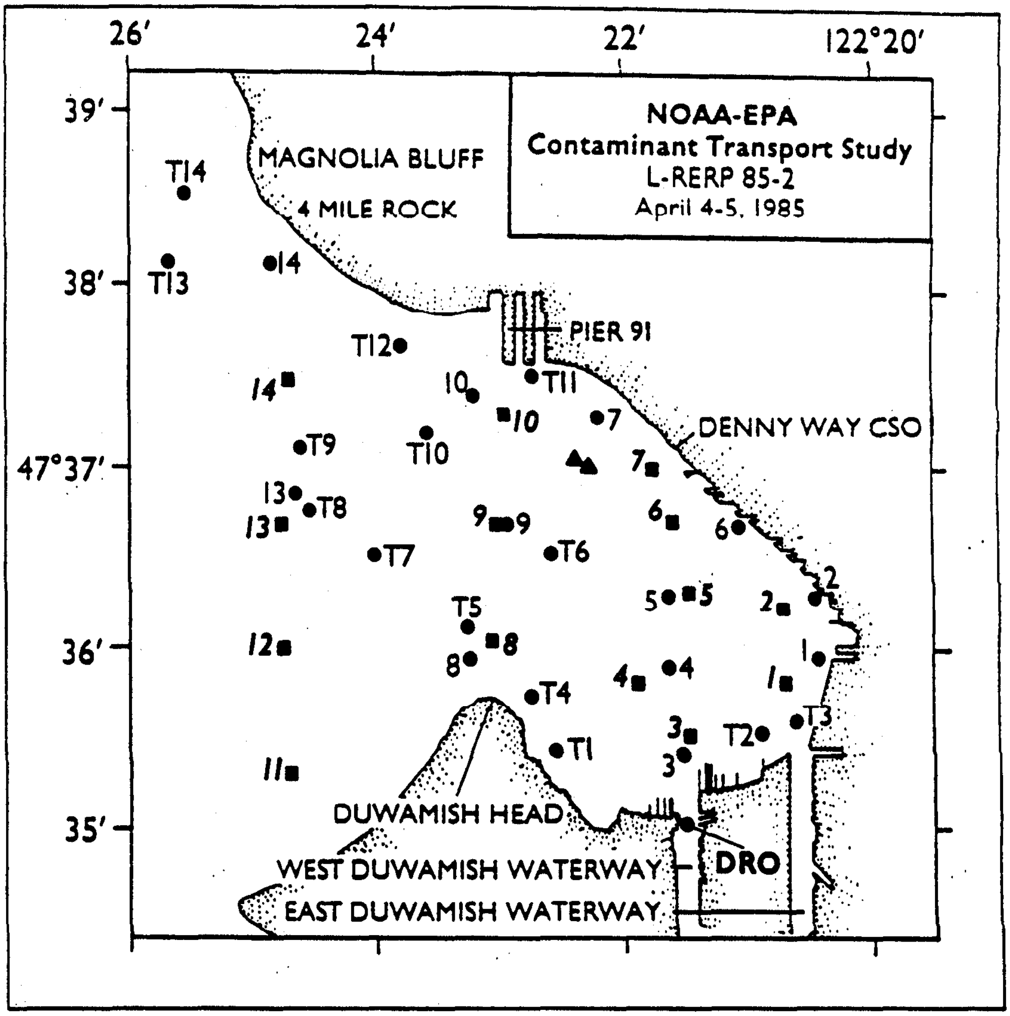
Chemical	Sediment Trap Data		Surface Sediment Composite Data			Sediment Coring Data	
						HC-B01	HC-B02
	Pier 63A	Pier 63B	HC-SS01	HC-SS02	HC-SS03	0 to 4 cm	0 to 4 cm
Bulk Parameters:							
Deposition Rate (gm DW/cm2-yr)	0.86	0.84					
210-Pb Activity (dpm/gm DW)	4.05	4.35				4.03	2.14
Total Solids (%)	26.8%	25.5%	55.1%	40.4%	60.4%	37.7%	34.4%
Total Organic Carbon (% DW)	3.9%	4.7%	1.5%	1.5%	1.5%	8.5%	14.9%
Metals (mg/kg DW):							
Aluminum	65,200	55,900					
Arsenic	16	15					
Calcium	18,200	16,900				9,880	3,860
Chromium	94	93					
Copper	118	117					
Iron	40,200	41,400					
Lead	156	186	486	704	420	569	1,180
Manganese	584	548					
Mercury	0.74	0.76	0.45	0.60	0.25		
Nickel	44	39					
Silicon	226,000	224,000					
Zinc	221	236	665	1,030	306	484	582
Low Weight PAHs (mg/kg DW):							
Naphthalene	0.13	0.33	1.6	3.3 J	1.8 J	5.4	8.4
Acenaphthalene	1.00	1.10	1.4	1.7 J	2.6 J	3.6 J	3.9
Acenaphthene	0.40	0.69	0.9	2.4 J	1.9 J	3.1 J	20.0
Fluorene	0.95	1.20	1.2	5.0 J	3.9 J	8.8	26.0
Phenanthrene	7.20	6.30	6.2	20.0 J	43.0	41.0	88.0
Anthracene	7.40	7.00	4.2	31.0 J	5.9	44.0	80.0
Total PP-LPAH	17.08	16.62	15.5	63.4 J	59.1	105.9	226.3
Total PP-LPAH (mg/kg TOC)	438	354	1,064	4,144 J	3,888	1,252	1,519
High Weight PAHs (mg/kg DW):							
Fluoranthene	13.00	15.00	11.0	33.0 J	57.0	87.0	62.0
Pyrene	12.00	13.00	28.0	48.0 J	54.0	81.0	140.0
Benzo(a)Anthracene	8.70	9.00	15.0	32.0 J	10.0	48.0	51.0
Chrysene	15.00	15.00	9.3	27.0 J	18.0	52.0	75.0
Benzo(b)Fluoranthene	11.00	11.00	0.6 U	11.0 J	8.4	4.6 U	57.0
Benzo(k)Fluoranthene	8.10	8.00	29.0	32.0 J	4.0 U	85.0	71.0
Benzo(a)Pyrene	10.00	10.00	8.1	17.0 J	7.2	42.0	64.0
Indeno(1,2,3-cd)Pyrene	4.80	4.80	4.3	7.7 J	3.2 J	13.0	29.0
Dibenzo(a,h)Anthracene	1.40	1.50	2.0	2.9 J	4.0 U	5.2	12.0
Benzo(g,h,i)Perylene	4.20	4.20	4.3	8.1 J	4.0 U	13.0	32.0
Total PP-HPAH	88.20	91.50	111.3	218.7 J	163.8	428.5	593.0
Total PP-HPAH (mg/kg TOC)	2,262	1,947	7,623	14,294 J	10,776	5,065	3,980
Polychlorinated Biphenyls:							
(mg/kg DW)	0.27		0.97	0.86	0.67	1.06	13.20
(mg/kg TOC)	7		66.	56	44	13	89

NOTES:

a. "U" denotes that the analyte was not detected; value presented is the sample detection limit.

b. "J" denotes that the analyte was positively identified, but the associate numerical value is estimated.

Table 6. Hart Crowser (1990)



Sampling locations in Elliott Bay for L-RERP 85-2. Surface samples by small boat stations (●), vertical profiles (■) and sediment trap mooring (▲).

Figure 42. Paulson *et al.* (1991a)

Location of moored equipment.

Mooring	Location	Depth	Duration
CB-3	47°16′24″N 122°27′12″W	25	3/25/81–5/4/81
CB-4	47°17′37″N 122°26′48″W	123 123	3/25/81–5/4/81
CB-5B	47°19′48″M 122°26′48″W	73	3/25/81–5/4/81
PS85-01	47°37′02″N 122°22′42″W	6 50	3/29/85–4/6/85 3/29/85–4/6/85
PS85-02	47°37′06″N 122°22′42″W	95 98 101	3/29/85–4/6/85 3/27/85–7/9/85 3/22/85–7/9/85
PS85-04	47°17′44″N 122°27′31″W	6	3/26/85–4/15/85 4/1/85–4/2/85
PS85-05	47°17′39″N 122°27′15″W	150	3/26/85–4/15/85 4/1/85–4/12/85

Table 7. Paulson *et al.* (1991a)

Trace metals in sediment trap samples (in units of wt./wt. sample).

Mooring	Bay	Depth ppm	Vertical mass flux (g/m^{-2}day^{-1})	Cu ppm	Mn ppm	Cd ppm	Pb ppm	Fe wt%	Zn ppm	As	Cr
CB-4	Commencement	23	5.91	102	610		55	3.99	435	35	67
		123	81.93	73	910		39	4.14	115	24	67
85-1	Elliott	6	0.09 (0.16±0.07)	52	553	*	100	4.25	480†		
		52	0.11 (0.16±0.05)	76	1113	3.60	229	4.64	287†		
85-2	Elliott	95	7.3 (7.7±1.9)	61	1725	0.17	76	4.49	156		
85-4	Commencement	6	0.22 (0.22±0.07)	52	625	0.16	68	3.82	159		
85-5	Commencement	150	31.7 (29.3±8.7)	57	1436	0.21	48	4.59	123		

* Below detection limit
† Contamination from mooring 85-1 suspected

Table 8. Paulson *et al.* (1991a)

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TRACE ORGANICS
(in total ng/g)
COLLECTED BY SEDIMENT TRAPS

MOORING#	85-1/17	85-1/20	85-2/18	85-4/15	85-5/16
DEPTH(m)	6m	50m	95m	6m	150m
START/STOP	32985, 62285	32985, 62285	32985, 62285	32685, 41585	32585, 41585
LATITUDE	47°37.0'N	47°37.0'N	47°37.0'N	47°17.6'N	47°17.6'N
LONGITUDE	122°22.7'W	122°22.7'W	122°22.7'W	122°27.5'W	122°27.3'W
LOCATION	ELLIOTT BAY	ELLIOTT BAY	ELLIOTT BAY	COMM. BAY	COMM BAY
Phe	590	820	440	<260	190
Ant	160	270	190	<260	53
MPh	320	670	360	<260	370
Fla	1000	930	720	<260	240
Pyr	900	850	630	<260	200
Ret	150	380	260	<260	400
BAA	340	330	260	<260	62
Chr	710	580	410	<260	90
BFl	520	580	560	<260	124
BEP	320	330	250	<260	84
BAP	210	230	280	<260	90
IPy	210	230	280	<260	90
BPe	210	230	280	<260	90
DDE	12	<5.2	<.18	<26	<.15
DDT	<21	<21	<.71	<104	<.61
DDD	<21	<21	<.71	<104	<.61
CL2	<5.2	<5.2	<.18	<26	<.15
CL3	<5.2	<5.2	<.18	<26	<.15
CL4	<8.3	<8.4	5.5	<42	0.7
CL5	12	<8.4	15	<42	2.2
CL6	33	<5.2	12	<26	2.3
CL7	<8.3	<8.4	5.9	<42	1.4
CL8	<8.3	<8.4	3.2	<42	<.24
CL9	<17	<17	.81	<84	<.48

Table 9. Curl et al. (1987)

VI. SEDIMENT ACCUMULATION RATES

Most Useful References: 3, 4, 17, 18, 36, 55, 75, 94, 95, 101, 103

Other References: 6, 17, 22, 30, 35, 43, 45

Synopsis of Information Found: Baker (1982), Baker, *et al.*, (1983), and Curl, *et al.*, (1987, 1988) used previously mentioned sediment traps to calculate SPM vertical fluxes (Table 10).

In the Pier 64/65 study, Hart Crowser reports average sediment accumulation rates of 0.85 g/cm^2-yr (0.63 cm/yr) in traps compared to 0.26 g/cm^2-yr (0.19 cm/yr) in cores (Table 11). The difference was explained by resuspension of bottom materials (see Section VII).

URS and Evans-Hamilton (1986) have tabulated sedimentation rates determined from cores collected at 150-288 m in and around Elliott Bay (Table 12). Rates ranged from 0.14 - 3.12 cm/yr with a mean of 1.38 cm/yr.

Tetra Tech (1988b,c) selected sedimentation rates of 0.2 and 0.7 cm/yr to evaluate recovery of contaminated sediments off the Denny Way CSO and Duwamish River Slip 4. Harper-Owes (1983) and Weston (1993) also estimated sedimentation in the Duwamish estuary. The most recent of these studies (Weston 1993) estimated accumulation rates for the south end of Harbor Island and Kellogg Island at 1.0 inches/yr (2.5 cm/yr). Weston (1993) also estimated that the north end of West and East Waterways were eroding at a rate of 2-3 inches/yr (5.1-7.6 cm/yr).

Conclusion: Sediment accumulation data for the study area are limited to the Hart Crowser study, although additional estimates of rates for the general Elliott Bay/Duwamish estuary are available. Sedimentation rate estimates for the waterfront range from 0.19 to 0.7 cm/yr, and range up to 3 cm/yr in the central basin.

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Characteristics of the trapped material in Elliott Bay

Trap/Depth	Flux ($g/m^2/day$)	Organic matter (%)	Size Distribution: Mean ϕ	Modal ϕ	>4ϕ (%)	Aggregate in >4ϕ fraction (%)
EB4						
Summer/30 m	0.66 0.75	23.0 17.7	5.3* 6.3	>4 7	44.8 18.1	92.7 85.4
Summer/132 m	37.9 37.0	12.8 10.9	6.6 6.8	7 7	5.2 7.1	97.1 75.3
Winter/130 m	32.7 30.0	9.6 8.9	6.0 6.3	7 7	4.8 5.2	81.9 85.1
EB2						
Summer/92 m	30.1 33.1	8.6 12.3	6.7 7.0	7 8	5.3 4.3	88.7 87.9
Winter/30 m	6.7 6.6	11.3 9.1	5.9 6.5	7 7	13.4 10.9	79.0 79.8
Winter/90 m	22.1 22.3	7.9 6.9	6.0 5.9	7 7	6.2 8.6	66.5 71.0

* Median, not mean, for this trap

Table 10. Baker (1982)

Sediment Trap Deposition Rates

Trap No.	Percent Solids	Accumulated Dry Weight in Grams	Sediment Flux in gm DW/cm^2·yr
Pier 63A	26.8	61.	0.86
Pier 63B	25.5	60.	0.84
Elliott Bay Mooring PS8501 (Curl et al., 1988)			0.0057
Central Puget Sound Mooring PS7 (Baker et al., 1985)			0.062

Table 11. Hart Crowser (1990)

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Sedimentation rates measured in central Puget Sound and Elliott Bay.

Station/Core Number	Location	Water Depth (m)	Sedimentation Rate (cm/yr)	Sampler Used	Method of Analysis	Reference
Core #5	47 36.5'N 122 25.7'W	194	1.40	Box Core	137Cs	Romberg et al., 1984
BPS-19	47 36.9'N 122 26.7'W	205	2.00	Kasten Core	Stable Pb	
BPS-20	47 36.6'N 122 25.2'W	199	2.04	Kasten Core	Stable Pb and 210Pb	
BPS-21	47 36.6'N 122 24.1'W	155	0.88	Kasten Core	Stable Pb	
K-4	47 35.7'N 122 25.3'W	201	2.0	Kasten Core	210Pb	Nevissi and McClain, 1984
K-6	47 35.7'N 122 24.8'W	150	1.3	Kasten Core	210Pb	
K-7	47 36.05'N 122 25.2'W	190	1.8	Kasten Core	210Pb	
6101	47 48.8'N 122 26.3'W	170	0.36	Multiple Core	210Pb	Carpenter et al., 1985
6102		171	0.56	Box core	210Pb	
5101	47 40.3'N 122 26.4'W	246	0.41	Multiple Core	210Pb	
5102		249	0.12	Box Core	210Pb	
5103		288	0.17	Box Core	210Pb	
5104		284	0.14	Box Core	210Pb	
C	47 32.5'N 122 26.4'W	212	2.4	?	210Pb	

Table 12. URS & Evans Hamilton (1986)

Sedimentation rates measured in central Puget Sound and Elliott Bay. (cont.)

Station/Core Number	Location	Water Depth (m)	Sedimentation Rate (cm/yr)	Sampler Used	Method of Analysis	Reference
6	47 31.6'N 122 25.4'W	201	2.48	Kasten Core	210Pb	Lavelle, Massoth, and Crecelius, 1985
6a	-	-	3.12	-	210Pb	
7	47 36.9'N 122 26.75'W	205	1.52	Kasten Core	210Pb	
8	47 39.75'N 122 27.9'W	229	1.20	Kasten Core	210Pb	
12	47 43.0'N 122 24.3'W	188	0.98	Kasten Core	210Pb	
12a	-	-	0.97	-	210Pb	
12b	-	-	1.03	-	210Pb	
13	47 42.3'N 122 26.4'W	199	1.92	Kasten Core	210Pb	
13a	-	-	1.88	-	210Pb	
13b	-	-	2.37	-	210Pb	

Average of all cores	1.38	Minimum value:	0.12
Standard deviation	0.84		
		Maximum value:	3.12
Average of all stations	1.54		
Standard deviation	0.72	Median value:	1.4

Table 12. Continued

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VII. RESUSPENSION

Most Useful References: 3, 4, 18, 19, 21, 36, 55, 83, 101

Other References: 1, 2, 22, 103

Synopsis of Information Found: The topic of resuspension of bottom material in Elliott Bay is discussed for deep water areas by Sillcox, *et al.*, (1981), Baker (1982, 1983), Pavlou, *et al.*, (1982), Dexter (1984), URS Engineers and Evans-Hamilton (1986), Curl, *et al.*, (1987) and Army Corps Engineers (1988a,b). Hart Crowser (1990) evaluated resuspension at Pier 64/65. All but Hart Crowser conclude the potential for resuspension is low.

Sillcox, *et al.*, (1981) state that currents of 23.5 cm/sec at 2m above bottom will resuspend unconsolidated coarse silt, but that higher speeds would be required to move the consolidated sediments of Elliott Bay. Bottom currents at NOAA's moorings (Figure 1) exceeded this speed only infrequently. URS Engineers and Evans-Hamilton (1986) made in situ measurements of sediment stability in water as shallow as 31 feet just east of Duwamish Head and found current velocities greater than 30 cm/sec were needed to initiate sediment movement. The NOAA studies of 1985-1986 summarized by Curl, *et al.*, (1987) showed speeds above 6 cm/sec occurred less than eight percent of the time in the bottom waters south of Pier 91 and near bottom in the Duwamish West Waterway. Although Baker (1982, 1983) observed relatively high concentrations of SPM near bottom in Elliott Bay, he concluded this was primarily due to advection from the main basin - where currents are high - and not local resuspension.

Dexter, *et al.*, (1984) calculated sediments of size 5 phi (31 um, coarse silt) or finer could be resuspended approximately one day per year at the previously mentioned dredge disposal site in the south bay. PSSDA studies concluded dredged material at the inner Elliott Bay disposal site was not eroded by bottom currents (Army Corps of Engineers, 1988a,b).

For Pier 64/65 however, Hart Crowser (1990) concluded: "Considerable sediment resuspension appears to occur in the site vicinity. Based on a comparison of sediment trap and in-place sediment data, approximately two-thirds of the material deposited in the study area may be resuspended material. The original source of the resuspended material cannot be determined with the available data, but may include large areas of the central and southern Seattle waterfront."

The report concludes with a discussion of the need for remediation, potential for natural recovery following source controls, and scope of remediation needed. The greatest need for remediation was for PAH; mercury was said to have a natural source in the Green River: zinc, lead and PCBs had evidence of decline over time.

Conclusion: The results of Hart Crowser (1990) suggest resuspension may be important in the study area.

VIII. ONGOING MONITORING ACTIVITIES

Most Useful References: 48, 77, 79

Other References: 64, 65, 86

Synopsis of Information Found: There are several ongoing monitoring programs in Elliott Bay that will be collecting data over the next 10 years in Elliott Bay and at the mouth of the Duwamish River. Within and just north of the study area, there are two long-term monitoring efforts associated with sediment caps that have been placed over contaminated sediment near CSOs or sewer outfalls.

Within the study area, METRO and the City of Seattle placed a cap offshore of Piers 53-55 on state-owned sediments to the north and west of the former deepwater outfall at Madison St (METRO 1992). Pre- and post-cap monitoring were conducted before and after cap placement in 1992. Additional sediment quality information was collected in 1993 on the cap and at three stations just south of the cap. Similar monitoring is planned for 1996 and 2002, beyond the time period of the recontamination study. Although one of the primary purposes of the monitoring was to determine whether long-term recontamination of the cap would occur, a one-time release of creosote-contaminated sediments from the adjacent Ferry Terminal has recontaminated the cap above cleanup levels (Romberg 1993c) and may have obscured interpretation of the data with respect to long-term trends.

Post-cap monitoring is also occurring offshore of the Denny Way CSO, just north of Pier 71. Monitoring of sediment quality on the cap has occurred in 1990, 1991, and 1992, and is planned for 1994. Preliminary data indicate that some recontamination of the cap has occurred; however, it is not known whether the recontamination is due to area-wide deposition, resuspension of nearshore contaminated sediments not covered by the cap, or continued discharge of contaminants from the Denny Way CSO (Romberg 1993b).

Outside the study area, the Puget Sound Ambient Monitoring Program annually monitors sediment quality at two stations in Elliott Bay, one near Magnolia Bluff and one in the Central Basin (Striplin 1988). The NOAA Status and Trends Program also monitors sediment chemistry and english sole bioaccumulation at one station off the north end of Harbor Island, approximately every two years. These data are useful in identifying overall long-term trends for Elliott Bay, but are not expected to provide information directly applicable to sites along nearshore areas of the waterfront.

DNR has monitored the PSDDA disposal site in Central Elliott Bay in 1988, 1990, and 1992. Future monitoring is dependent on the volume of dredged material disposed of at the site, and will likely occur in either 1994 or 1995. Most stations are located within or at the perimeter of the disposal site; however, four background stations are located to the north, south, east, and west of the disposal site (PSDDA 1988). The eastern background station is located about 500 ft. west of the study area, at approximately Washington St., and the southern background station is located approximately 1,750 ft. north of the east end of Terminal 3, at the mouth of West Waterway. At the 1993 Annual Review Meeting, the Corps of Engineers reported that a general increase of contaminant concentrations has been observed in the background stations, unrelated to disposal of dredged sediments and indicating a baywide source. However, the concentrations at background stations are still well below Sediment Quality Standards (PSDDA 1993).

Future Monitoring (Unscheduled): Several one-time sampling events are likely to occur within the 1993-1995 timeframe at contaminated sediment sites along the waterfront and in Elliott Bay. Within the study area, there are three possibilities. Negotiations are ongoing for characterization of potentially contaminated sediments at the Unocal Seattle Marketing Terminal (Pier 71). In addition, the Elliott Bay/Duwamish Restoration Program is considering characterization of high-scoring waterfront sites concurrent with this study. Finally, DOT will be requested to characterize sediments surrounding the Colman Dock as a result of a recent release of contaminants in that area.

Other sites in Elliott Bay at which sediment characterization may occur in the next few years include Lockheed Shipyard, Todd Shipyard, ARCO, and Texaco on Harbor Island; various Port of Seattle facilities, including possible additional characterization at Terminal 3; and Wyckoff West Seattle. The Elliott Bay/Duwamish Restoration Program also plans to conduct site characterization at four high-ranking sites selected by the Panel in the Duwamish River (Diagonal, Duwamish Pump Station, West Michigan, and Norfolk outfalls).

In addition, several facilities are expected to conduct sediment sampling in the next few years as part of baseline monitoring for an NPDES permit. These facilities include Duwamish and Todd Shipyards (expected in late 1993) and various METRO and City outfalls, including West Point, Alki, and Renton STP, and large CSOs in Elliott Bay and Duwamish River. The final schedule for the outfall sampling has not been finalized, but is expected to take place sometime in 1995.

Conclusion: Although several monitoring programs are ongoing in Elliott Bay, none are located directly in the study area, with the exception of the Pier 53-55 monitoring. The next round of monitoring is not scheduled to occur until 1996. In addition, evaluation of data from monitoring programs along the waterfront has been complicated by the effects of localized sources. The most important supporting information will likely be collected by future sediment sampling during NPDES baseline monitoring and characterization of contaminated sites along the waterfront. Several of these studies are likely to be conducted in the time-frame of the recontamination study.

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ELLIOTT BAY WATERFRONT RECONTAMINATION STUDY

Sampling and Analysis Plan

Prepared by

Toxics Investigations Section
Environmental Investigations and Laboratory Services Program
Washington State Department of Ecology
Olympia, Washington

Water Body #WA-09-0010

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INTRODUCTION

Problem Description

The Elliott Bay/Duwamish River Restoration Panel is currently evaluating potential cleanup sites in Elliott Bay and the Duwamish River that will require remedial actions. Remediation alternatives under consideration include: dredging and disposal, capping with clean sediments, and enhanced natural recovery.

Recent studies have suggested that recontamination of bottom sediments along the central Seattle Waterfront is a concern and could affect the long-term success of cleanup projects. Potential sources of recontamination include: ongoing discharges (combined sewer overflows, storm drains, etc.), resuspension and redistribution of contaminated bottom sediments, and longshore transport of contaminants from other areas of Elliott Bay and the Duwamish River. The potential for recontamination needs to be determined prior to conducting sediment remediation projects.

This document describes sampling and analysis activities to be undertaken for the Elliott Bay Waterfront Recontamination Study. Recommendations from attendees at the Field Investigation Planning Meeting held on August 12 have been incorporated into the sampling design where appropriate.

The study area, shown in Figure 1, is generally defined as the nearshore (<75') waterfront area extending from Terminal 46 on the south to Pier 59 on the north.

Survey Objectives

The overall goal of the Elliott Bay Waterfront Recontamination Study is to determine if it is feasible for the Elliott Bay/Duwamish Restoration Panel to undertake sediment remediation projects within the waterfront area by 1997. More specifically, the major objectives of the field investigation portion of the study are as follows:

- Characterize chemical concentrations (metals and organics) associated with settling particulate matter (SPM) at various points along the central Seattle Waterfront;
- Determine sediment accumulation rates in the study area, including an estimation of net sedimentation (deep burial) and resuspension (gross sedimentation - net sedimentation);
- Estimate current velocity (speed and direction) in various portions of the nearshore waterfront area; and
- Identify sediment transport pathways and areas of deposition and erosion.

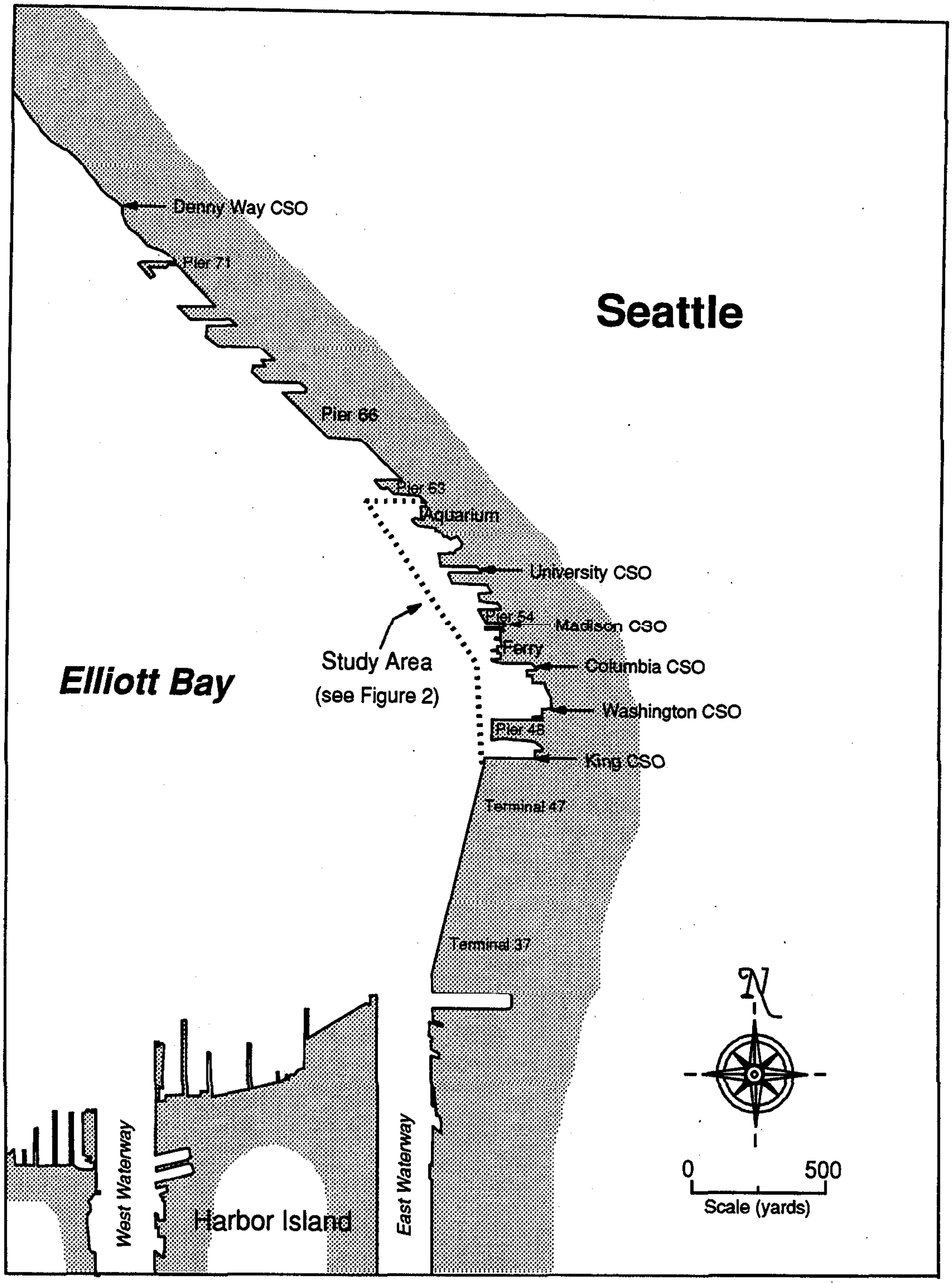

Figure 1: Location of Study Area for the Elliott Bay Waterfront Recontamination Study.

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The results from the field investigation portion of the study will be used in conjunction with modeling efforts to answer the overall objective of the Waterfront Recontamination Study.

METHODS

Site Selection

Proposed sampling locations, shown in Figure 2, were selected to characterize spatial variability between different regimes in the study area (*i.e.*, near CSO, under piers, within slips, and expose pier faces). Detailed descriptions of each station and the purpose for its location are provided in Table 1.

Station positions will be recorded with the use of a Magellan Nav 5000D® GPS receiver, in conjunction with depth readings. Distances from fixed onshore structures will also be recorded.

Sampling Procedures

To characterize present conditions in the nearshore area of the Central Seattle Waterfront settling particulate matter (SPM), bottom sediments, sediment cores, current velocity measurements and vertical profiles of light transmittance will be collected between October 1993 and October 1994. Table 2 presents a summary of the proposed sampling for the Elliott Bay Waterfront Recontamination Study. Each component of the field investigation is briefly described below. In addition, field work will be conducted in accordance with procedures outlined in the *Elliott Bay Waterfront Recontamination Study Health and Safety Plan.*

Grain Size Mapping

To define depositional and erosional environments within the Waterfront Recontamination Study area, surface sediments (top 2cm) were collected along fifteen transects (north to south) and analyzed for "apparent" particle size (PSEP, 1986). Where feasible spacing between stations, at a minimum, was 40 yards moving offshore to a maximum depth of 60 feet and 100 yards between transects moving north to south. However, due to physical limitations encountered in the field this grid had to be modified. Approximate locations of the grain size transects sampled are shown in Figure 3.

To evaluate comparability of grain size data generated using the Puget Sound Estuary Protocols (PSEP) method (apparent grain size) and data generated for the Puget Sound Dredge Disposal Analysis (PSDDA) blind field duplicates (a single sample homogenized and split into two aliquots) were prepared at approximately 10% of the stations sampled. Grain size results generated for PSDDA differ from PSEP in that they are reported as "true"

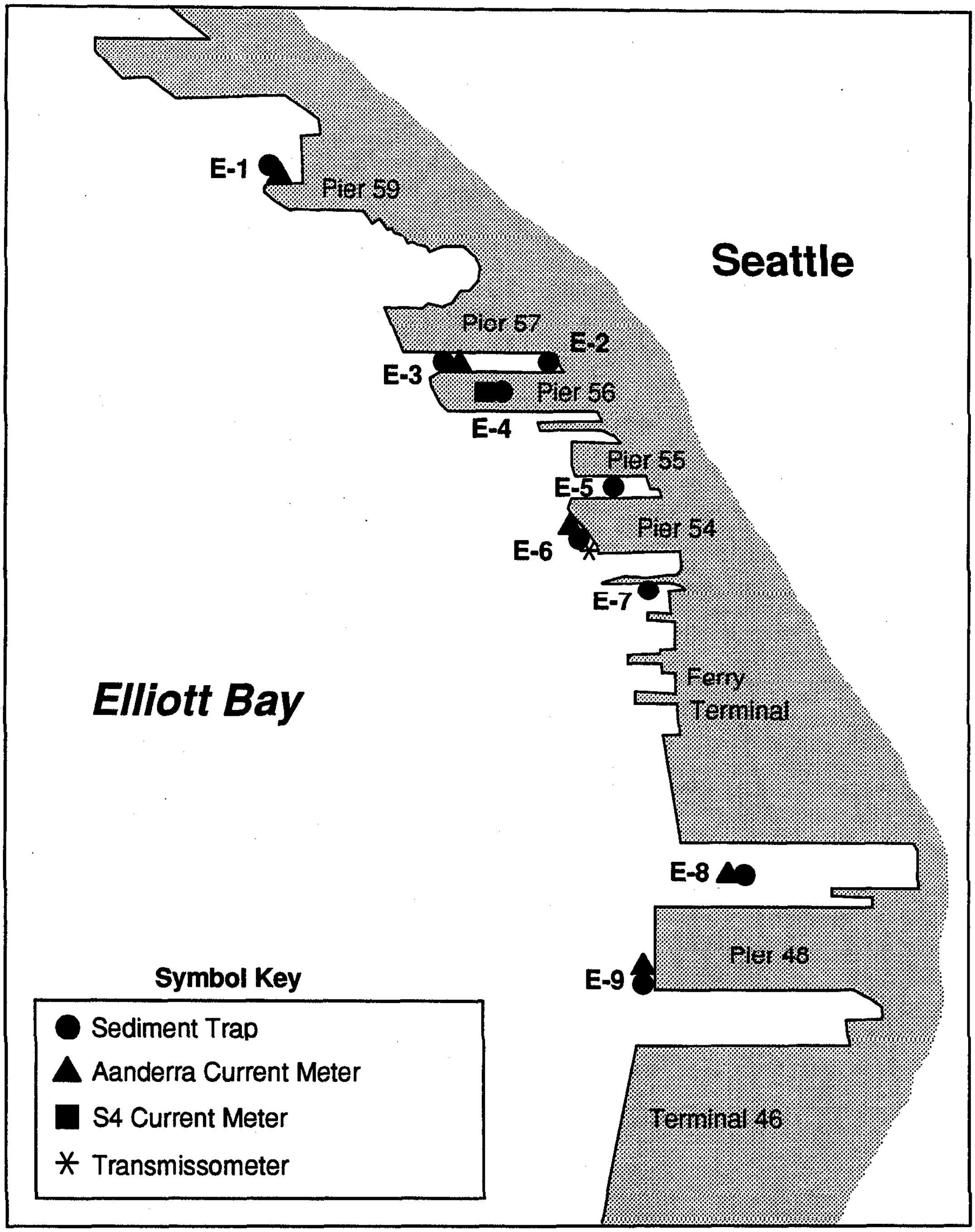

Figure 2: Station Locations for the Elliott Bay Waterfront Recontamination Study.

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Table 1: Station locations for the Elliott Bay Waterfront Recontamination Study.

Station	Location	Est. Depth (ft @ MLLW)	Sample Type	Purpose
E-1	Northwest Corner of Pier 59	60	ST*,ACM	Northern boundary of study area- exposed conditions
E-2	Between Pier 56 and 57 at head near Univ. CSO	30	ST	Near CSO discharge (head of slip- gradient)
E-3	Between Pier 56 and 57 at mouth of slip (center)	50	ST,ACM	Between piers (mouth of slip- gradient)
E-4	Under Pier 56	25	ST,S4	Under pier conditions
E-5	Between Piers 54 and 55 (center of slip)	25	ST	Between piers (short slip)
E-6	West end of Pier 54	50	ST*,ACM*,T	Center of study area- exposed conditions
E-7	Adjacent to Fire Boat Pier (Station #5)	25	ST	Ferry Terminal effects
E-8	North of Pier 48 (center of slip)	40	ST,ACM	Between piers (long-wide slip)
E-9	Southwest corner of Pier 48	60	ST,ACM	Southern boundary of study area- exposed conditions

ST= Sediment Trap

ACM= Aanderra Current Meter

S4= Current Meter

T= Vertical array of Transmissometers (Surface, mid-depth, and bottom)

*= Deployed at surface and bottom of Water Column

Table 2: Summary of sampling for the Elliott Bay Waterfront Recontamination Study.

Analysis	Sampler	Sampling Frequency	Duration of Deployment
I. WATER			
Current Velocity	Aanderra RCM-4	Quarterly	One Year
" " "	S4	"	Six Months
Light Transmittance	Transmissometers	Monthly	One Year
II. SETTLING PARTICULATE MATTER			
Percent Solids	Sediment Traps	Quarterly	One Year
Grain Size	"	"	"
Total Organic Carbon	"	"	"
Total Metals			
Aluminum	"	"	"
Arsenic	"	"	"
Cadmium	"	"	"
Chromium	"	"	"
Copper	"	"	"
Iron	"	"	"
Lead	"	"	"
Manganese	"	"	"
Mercury	"	"	"
Silver	"	"	"
Zinc	"	"	"
Organics			
Semivolatiles	"	"	"
PCBs	"	"	"
Pb-210	"	"	"
III. BOTTOM SEDIMENT CORES			
Percent Solids	Kasten or alternate	Once	N/A
Grain Size	"	"	"
Total Organic Carbon	"	"	"
Metals			
Aluminum	"	"	"
Copper	"	"	"
Iron	"	"	"
Lead	"	"	"
Manganese	"	"	"
Mercury	"	"	"
Zinc	"	"	"
Organics			
PCBs	"	"	"
Pb-210	"	"	"
Cs-137	"	"	"
IV. BOTTOM SEDIMENT			
Grain Size Mapping	Van Veen/Ponar	Once	N/A

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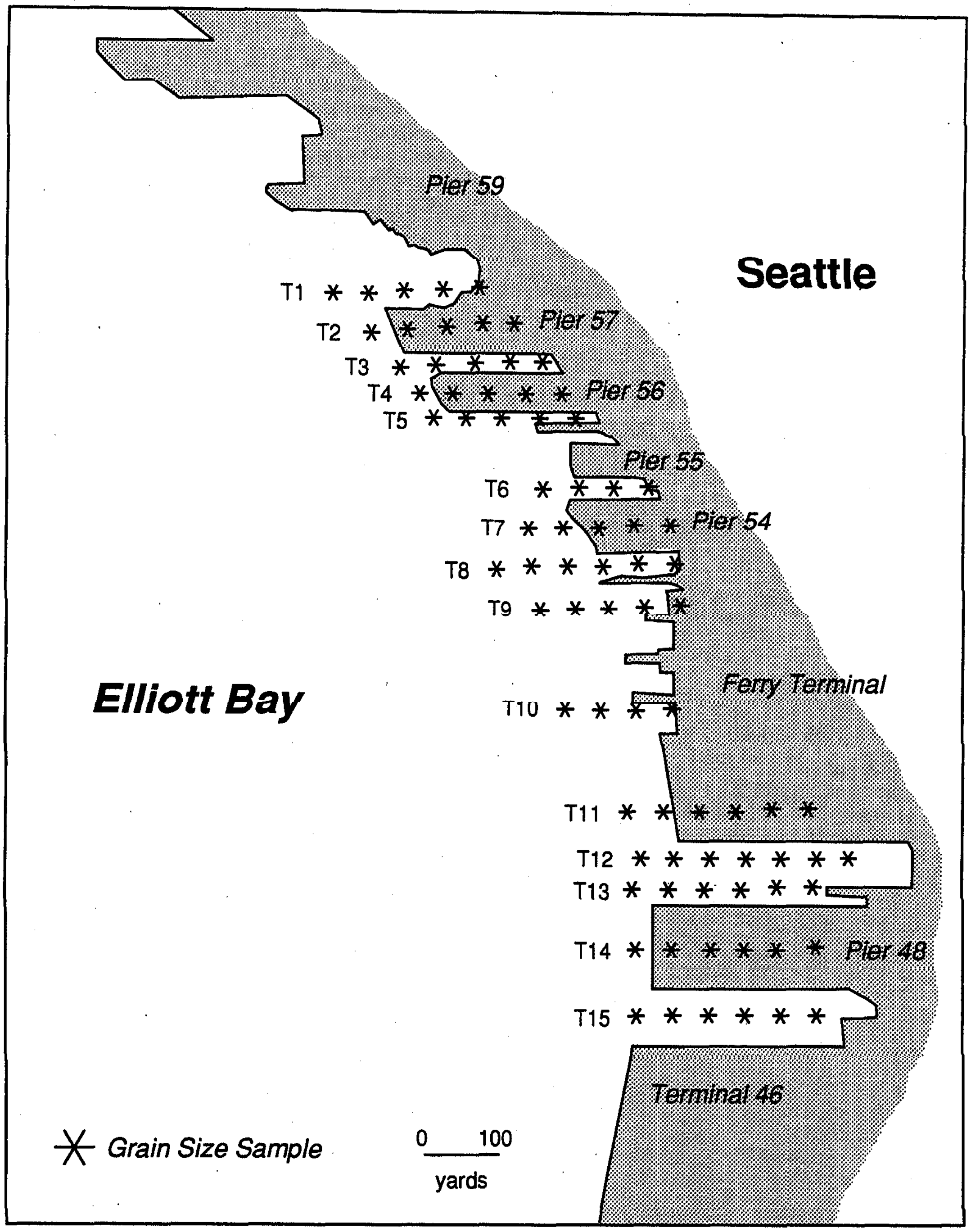

Figure 3: Locations of Transects for Grain Size Mapping, Elliott Bay Waterfront Recontamination Study.

particle size (hydrogen peroxide addition). In addition, to assess environmental variability field replicates (a separate sample from a similar location) were also prepared at approximately 10% of the locations.

The grain size data obtained will be used to contour percent clay levels in bottom sediments. These grain size plots will ultimately be used to aid in selecting locations for bottom sediment cores and be used to define erosional and depositional environments in the study area.

Water

Current velocity measurements will be made at 6 locations. Aanderra® Model RCM-4 current meters will be used at 5 of the 6 stations (E-1, E-3, E-6, E-8, and E-9) to measure near bottom current velocities. The meters will be deployed 3 feet off the bottom for a period of one year. In addition, at station E-6 one meter will also be deployed in the upper 5 feet of the water column to measure surface velocities. To evaluate short term velocity increases, that might be expected from vessel traffic, each meter would be set to a recording interval of 15 minutes.

At the remaining station (E-4) a S-4 current meter will be deployed under Pier 56 for 6 months, beginning in quarter 2 and ending in quarter 3 (January-July, 1994).

To aid in evaluating the height of sediment resuspension, at station E-6, three beam transmissometers will be placed in a vertical array. Transmissometers will be deployed at heights of 2 feet, 10 feet, and 20 feet above the bottom.

SPM

SPM will be collected at nine locations with the use of moored sediment traps positioned 3 feet above the bottom (see Figure 2). In addition, to evaluate surface (low salinity) and bottom (high salinity) conditions, at two locations (E-1 and E6) sediment traps will also be deployed in the upper 5 feet of the water column.

A diagram of the construction details of the traps is shown in Figure 4. These traps have been used by Ecology in the Waterways of Commencement Bay over the past four years to monitor contaminant concentrations associated with SPM and estimate bottom sediment resuspension rates (Norton and Barnard, 1992a,b; Norton, 1993).

Briefly, the traps are straight-sided glass cylinders with a collection area of $78.5 cm^2$ and a height to width ratio of 5. Each mooring holds two cylinders for a total collection area of $157 cm^2$ per mooring. To collect enough material for quarterly analysis of all parameters and reduce the possibility of missing data points, two independent moorings would be installed at each station.

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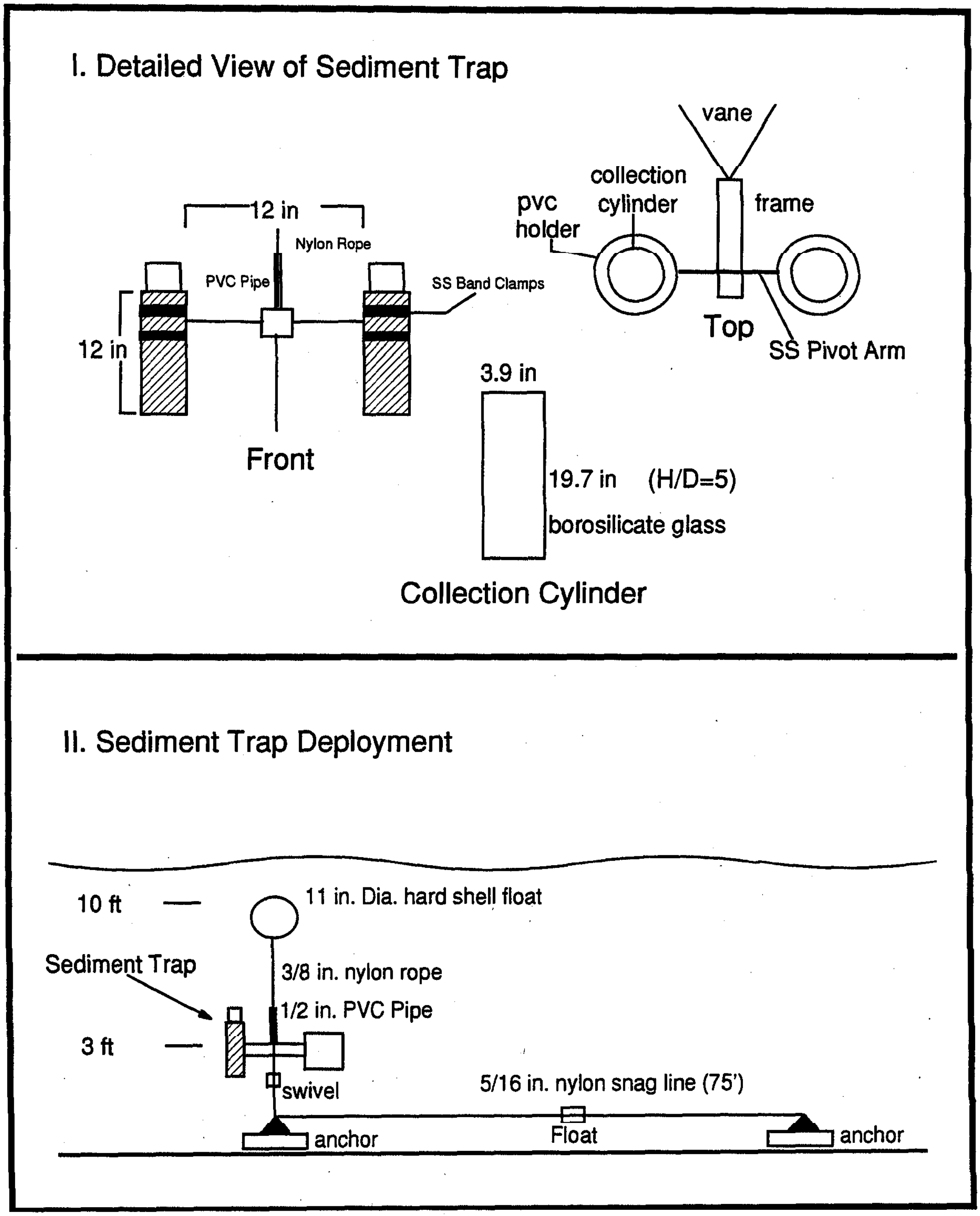

Figure 4: Diagram of Sediment Traps and bottom mooring to be used for the Elliott Bay Waterfront Recontamination Study.

Prior to deployment, the collection cylinders will be cleaned with sequential washes of hot tap water/Liquinox® detergent, 10% nitric acid, distilled deionized water, and pesticide grade acetone, then wrapped in aluminum foil until used in the field. At deployment the traps will be filled with two liters of high salinity distilled water (4% NaCl), which contains sodium azide (2%) as a preservative to reduce microbial degradation of the samples.

Upon retrieval of the traps, overlying water in the collection cylinders will be removed with a peristaltic pump. The salinity of water overlying the collected SPM will be tested to determine if the traps had been disturbed. SPM will then be transferred to 1/2 gallon sample containers and taken to the laboratory for processing, where the particulate fraction will be isolated with the use of a centrifuge. Based on preliminary calculations it is anticipated that approximately 100g of dry particulates will be available for analysis each quarter.

Sediment Cores

To supplement existing data, four sediment cores would be collected for Pb-210 and Cs-137 dating and selected chemical analysis. The location of the sediment cores will be determined after reviewing the results of grain size mapping and dredging records for the area. Each core, should at a minimum, be 100cm in length and sectioned into at least ten intervals for dating. Chemical analysis will be limited to five intervals and focus on selected metals and polychlorinated biphenyls (PCBs), (see Table 2). Analysis of metals and PCBs in the sediment cores could have several advantages including: providing data on bottom sediment concentrations of these contaminants and furnishing additional time markers to verify the Pb-210 dating results. In addition, aluminum, manganese, and iron concentrations can be used as indicators to evaluate the natural inorganic content among sediment samples.

Final selection of sampling intervals for both dating and chemical analyses would be determined after examining the core horizons. The coring device selected should be capable of collecting an adequate volume of material for all analysis, and to the extent possible, minimize shortening of the core.

Sediment coring will be completed no later then the third quarter of sampling to allow adequate time for analysis and data reporting.

Sample Handling

All sediment samples will be placed in appropriate containers, properly labeled and held on ice in insulated coolers. Ice will be held in watertight bags to prevent potential contamination of the samples. Samples will be removed at least every second day and transported directly to the analytical laboratory. Prior to transport, individual jars will be wrapped to prevent breakage.

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Sample tracking procedures will follow those outlined in the Manchester Laboratory Users Manual (Ecology, 1991). Briefly, Chain-of-Custody forms will be completed at the end of each day's sampling. The chief scientist will ensure that these forms are properly completed and signed at the time of sample transfer. One copy of the form will be placed into a waterproof bag and attached to the inside of each sample cooler. The chief scientist will keep the second copy. The coolers will be sealed and kept in a secured location when not in the possession of the chief scientist or assigned crew.

At the time the samples are received in the laboratory, the laboratory sample custodian will inspect the shipment to ensure that sample integrity has been maintained. Broken or inappropriate sample containers and inconsistencies in chain-of-custody forms will be documented. The project manager will be notified of such problems immediately.

Sample Analysis and Quality Assurance

All physical/chemical analyses of samples for the Elliott Bay Recontamination Study will be conducted using procedures specified in the Puget Sound Protocols (PSEP, 1986) as amended and updated, except for Total Organic Carbon, which will be analyzed according to the 1993 PSSDA modifications to the PSEP method. In addition, the type and frequency of laboratory quality assurance (QA) samples will at a minimum follow those specified in the Manchester QA Manual (Ecology, 1988). Table 3 presents a summary of proposed analytical methods, minimum detection limits, and data quality objectives for the Waterfront Recontamination Study.

All laboratories conducting analyses for this study will supply information needed to support a QA1 review of the data as specified in *PSDDA Guidance Manual- Data Quality Evaluation for Proposed Dredged Material Disposal Projects* (PTI, 1989). All data generated will undergo a quality assurance review to evaluate the precision and accuracy of the data set.

In addition, to standard laboratory QA samples, to assess analytical accuracy certified reference materials will be analyzed in duplicate at a frequency of one per sample batch for metals, polynuclear aromatic hydrocarbons (PAH), and polychlorinated biphenyls (PCBs). To evaluate overall precision one set of blind field duplicates (a single sample homogenized and split into multiple aliquots) will be prepared at a frequency of approximately 10%. Environmental variability will be evaluated by analysis of field replicates (a separate sample from a similar location) also at a frequency of 10%. Table 4 summarizes QA samples and their frequency of analysis for this project.

Table 3: Summary of proposed analytical methods, minimum detection limits, and data quality objectives for the Elliott Bay Waterfront Recontamination Study.

I. Analytical Methods

Analysis	Method	Reference
Total Solids	Dry @ 104°C	PSEP, 1986
Grain Size	Seive and Pipet Apparent (w/o H2O2 addition) True (w/ H2O2 addition)	"
Total Organic Carbon	Combustion/CO2 Measurement as modified by PSSDA	PSDDA, 1993
Total Metals		
Aluminum	ICP	EPA, 1986
Arsenic	GFAA	"
Cadmium	GFAA	"
Chromium	ICP	"
Copper	ICP	"
Iron	ICP	"
Lead	GFAA	"
Manganese	ICP	"
Mercury	CVAA	"
Silver	ICP	"
Zinc	ICP	"
Organics		
Semivolatiles	GC/MS #8270	EPA, 1986
PCBs	GC/ECD #8080	"
Pb-210	Polonium-210 activity	Koide et.al., 1973
Cs-137	Gamma Spectroscopy	-

II. Data Quality Objectives

Analysis	Detection Limits (mg/kg)	Precision (RPD)	Accuracy (%)	Completeness (%)
Total Solids	0.1%	20	10	90
Grain Size	N/A	20	10	90
Total Organic Carbon	0.1%	20	10	90
Metals				
Aluminum	0.1	20	10	90
Arsenic	0.1	20	10	90
Cadmium	0.1	20	10	90
Chromium	0.1	20	10	90
Copper	0.1	20	10	90
Iron	0.1	20	10	90
Lead	0.1	20	10	90
Manganese	0.1	20	10	90
Mercury	0.05	20	10	90
Silver	0.1	20	10	90
Zinc	0.1	20	10	90
Organics				
Semivolatiles	0.2	50	20	90
PCBs	0.2	50	20	90
Pb-210	0.1 dpm/g	15	10	90
Cs-137	0.1 dpm/g	15	10	90

RPD= Relative Percent Difference from Duplicate Analysis (Range as percent of mean)

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Table 4: Summary of quality assurance samples and frequency of analysis for the Elliott Bay Waterfront Recontamination Study.

Analyte	Internal Standards	Surrogate Spikes	Method Blank	Matrix Spike*	Reference Materials*	Field Duplicate*	Field Replicate
Percent Solids	-	-	-	-	-	2 Batch	1 Batch
Grain Size	-	-	-	-	-	2 Batch	1 Batch
Total Organic Carbon	-	-	1 Batch	2 Batch	-	2 Batch	1 Batch
Metals							
Aluminum	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Arsenic	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Cadmium	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Chromium	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Copper	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Iron	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Lead	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Manganese	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Mercury	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Silver	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Zinc	-	-	1 Batch	-	2 Batch	2 Batch	1 Batch
Organics							
Semivolatiles	1 sample	1 sample	1 Batch	2 Batch	(2 Batch)	2 Batch	1 Batch
PCBs	1 sample	1 sample	1 Batch	2 Batch	2 Batch	2 Batch	1 Batch
Pb-210	-	-	-	-	-	2 Batch	2 Batch
Cs-137	-	-	-	-	-	2 Batch	2 Batch

*= Samples are duplicates

()= PAH only

<u>Certified Reference Materials</u>

Metals- NIST #1646 (Estuarine Sediment)

PAH- NRCC #HS-6 (Harbour Marine)

PCBs- NRCC #HS-2 (Harbour Marine)

Sediment Transport Study

A large-scale sediment transport study of the Elliott Bay/Duwamish area will also be conducted to determine sediment transport pathways and potential linkages between contaminated sites in the region, and areas of erosion, equilibrium, and sediment deposition. The Sediment Transport Study will be conducted by GeoSea Consulting and funded in cooperation with EPA, DNR, NOAA, and the Port of Seattle.

The Sediment Transport Study would cover an area extending from approximately Slip 3 on the Duwamish River to a line in outer Elliott Bay extending from Alki Point to West Point. To provide adequate resolution, taking into consideration the variety of anthropogenic disturbances of sediments in Elliott Bay, and particularly along the Seattle Waterfront, three sample densities will be used.

Samples will be spaced at 10-second (310m) intervals on a grid in outer Elliott Bay. Outer Elliott Bay is defined as the area between a line running north from Alki Point to West Point then east to a line extending from Duwamish Head north to Smith Cove. In inner Elliott Bay (Duwamish Head to Smith Cove and east to the western edge of the Waterfront Recontamination Study area), an 8-second (250m) grid would be used. A smaller sample spacing (approximately 150m) will be used in the Duwamish Waterway and additional samples would be placed along the shoreline at the ends of piers, and nearshore between piers along the waterfront.

A total of approximately 500 samples will be collected in October 1993 using a van Veen or Ponar grab sampler, including 122 samples in outer Elliott Bay, 206 samples in inner Elliott Bay, 89 samples along the shoreline, and 81 samples in the Duwamish Waterways. Grain size analysis will be conducted by GeoSea Consulting using a Malvern 2600L laser particle sizer, supplemented by dry sieving where necessary. The data generated will be interpreted to identify sediment transport pathways and depositional trends using a statistical model developed by Patrick McLaren and described in detail in GeoSea Consulting (1993).

To provide a measure of field variability and model robustness, field replicates will be collected at selected stations in areas of high heterogeneity. The replicate grain size curves will be analyzed for percent difference. Two different data sets will be generated using replicate curves that are significantly different and modeling performed on each set, to determine the level of heterogeneity that results in a difference in model interpretation. An initial presentation of results will take place in early February, and will include expert review to guide final interpretation and write-up of the results.

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Meteorological Data

Meteorological data and oceanographic data over the course of the study will be obtained from the existing tidal station operated by NOAA at the DOT Ferry Terminal. The tidal station records wind speed and direction, air and water temperature and tide height. The variability, or "noise," associated with the tide height data can be correlated to sea state and wave height. These data are transmitted by satellite to NOAA computers and can be downloaded periodically to a spreadsheet.

Other Variables

As required by the model selected, other variables may be measured later in the study, including dispersion, total suspended solids, and particle fall velocity. These data will be collected as part of Task 3 once a modeling contractor and a model have been selected.

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ELLIOTT BAY WATERFRONT RECONTAMINATION STUDY

Modifications to the Sampling and Analysis Plan

May 1995

Several modifications to the *"Elliott Bay Waterfront Recontamination Study: Sampling and Analysis Plan"* dated November 2 1993 were made during the course of the field investigation. These changes are documented below;

Sampling Procedures

Grain Size Mapping- Spacing between sampling stations was originally planned to be 40 yards apart moving offshore to a depth of 60' and 100 yards between transects moving north to south. However, due to physical constraints encountered in the field (piers and pilings) this grid had to be modified. Actual spacing between stations was approximately 40 yards moving offshore and 50 yards between transects moving north to south. Final locations of the grain size stations are shown in the main body of Volume I, in Figure 4.

Current Velocity Measurements- Current velocity measurements were originally planned for six locations using Aanderra RCM4 meters. After reviewing current velocity information collected during the first quarter of monitoring it was apparent that a significant portion of the current speeds in the study area were below the RCM4's recording threshold of 2.5 cm/sec. To better characterize current velocities <2.5 cm/sec, starting on January 28 and ending October 14 two Interocean® S4 current meters were rotated monthly between a total of 11 locations (EB-1A, EB-2, EB-4, EB-6S, EB-6B, EB-8, EB-9, EB-10, EB-11, EB-12, EB-13, EB-14). For comparability with the RCM4 data, the S4 meters were set to record one minute averages every 15 minutes.

In addition, the meter at station EB-1 was moved offshore to station EB-1A during the third and fourth quarter of monitoring to better reflect conditions outside the pier line. In addition, at station EB-6 one meter was placed in the upper 7 feet of the water column to measure surface current velocities. This surface meter was placed at a lower depth (7' vs 3') to avoid swing conflicts with the sediment traps deployed from the same mooring.

Finally a ancillary data was collected at the end of the field investigation to estimate the effects of vessel prop wash on bottom currents. This was accomplished by deploying S4 current meters for two days between October 25-27 at two locations (EB-8 and EB-16). These meters were set to record 30 second averages of current velocity continuously.

The final locations of all current meter deployments are shown in Volume I, Figure 2.

Transmissometers- An attempt was made to evaluate the height of sediment resuspension at station EB-6 with the use of three 25 cm beam transmissometers in a vertical array at three depths. Transmissometers were placed at heights of 2 feet, 10 feet, and 20 feet above the bottom. Originally these instruments were to be serviced at a monthly frequency. Due to fouling of the optics this frequency was changed to bi-weekly. This change significantly increase the amount of staff field time. As a result transmissometer monitoring was terminated approximately 4 months early (June 1994).

Settling Particulate Matter- No changes to the planned deployments or sampling frequency of the sediment trap network was undertaken during the course of monitoring.

Sediment Coring- Final selection of a coring equipment was deferred to a later date in the original sampling and analysis plan. A 4" gravity barrel corer was ultimately used to collect deep cores.

Sample Analysis

Settling Particulate Matter- Due to insufficient volume of matter collected by the sediment traps the following physical and chemical analyses were dropped during the quarters indicated:

Quarter 1- TOC (EB-6S); Grain size (all stations except EB-5); ^{210}Pb (EB-1S, EB-1B, EB-2, and EB-6S); Semivolatiles (EB-1B, EB-2, and EB-6S); PCBs (EB-1B, EB-2, and EB-6S).

Quarter 2- Grain Size (EB-6-S); PCBs (EB-6S and EB-7); ^{210}Pb (EB-6S)

Quarter 3- No changes

Quarter 4- ^{210}Pb (all stations due to cost considerations)

A detailed discussion of the sampling and analysis conducted for the project is also present in the main body of the report under the methods section.

Appendix B - Field Information

Station Location Information (Table B1)

Deployment Schedule for Sediment Traps (Table B2)

Sample Tracking Sheets

Core Logs

Sediment Trap Design and Mooring Configuration (Figure B1)

Table B1: Station descriptions for the Elliott Bay Waterfront Recontamination Study.

Station	Location	Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Depth (ft @ MLLW)	Sample Type
Core Stations									
EB-1	Northwest of pier 59	47	36	29	122	20	38	41	ST*,ACM
EB-2	Between pier 56 and 57 at head near Univ. CSO	47	36	21	122	20	27	25	ST,S4
EB-3	Between Pier 56 and 57 at mouth of slip (center)	47	36	21	122	20	32	50	ST,ACM
EB-4	Under pier 56	47	36	20	122	20	28	25	ST,S4
EB-5	Between piers 54 and 55 (center of slip)	47	36	17	122	20	23	29	ST
EB-6	West end of pier 54	47	36	15	122	20	25	23	T*,ACM*,S4,
EB-7	Adjacent to former wing wall at Colman Ferry Termin	47	36	13	122	20	22	27	ST
EB-8	North of pier 48 (center of slip)	47	36	03	122	20	19	38	ST,ACM,S4
EB-9	South west end of pier 48	47	35	59	122	20	24	58	ST,ACM,S4
Current Velocity Only									
EB-1A	West end of pier 59	47	36	28	122	20	40	57	ACM,S4
EB-10	West of pier 58 (waterfront park)	47	36	26	122	20	37	72	S4
EB-11	Under pier 57	47	36	22	122	20	33	45	S4
EB-12	Northeast end of pier 52 (Coleman Ferry Terminal)	47	36	11	122	20	22	35	S4
EB-13	Under southwest end of pier 52	47	36	05	122	20	21	26	S4
EB-14	Northwest end of pier 48	47	36	02	122	20	25	58	S4
EB-16	West end of pier 56	47	36	19	122	20	33	70	S4

ST= Sediment Trap

ACM= Aanderra RCM4 Current Meter

S4= Interocean S4 Current Meter

T=Transmissometer- vertical array

*= Surface and bottom deployments

Table B1 (cont.): Station descriptions for the Elliott Bay Waterfront Recontamination Study.

Station	Location	Purpose
Core Stations		
EB-1	Northwest of pier 59 (surface and bottom)	Northern boundary of study area- Inside pier face
EB-2	Between pier 56 and 57 at head near Univ. CSO	Near CSO discharge (head of slip- gradient)
EB-3	Between Pier 56 and 57 at mouth of slip (center)	Between piers (mouth of slip- gradient)
EB-4	Under pier 56	Under pier conditions-narrow piling spacing
EB-5	Between piers 54 and 55 (center of slip)	Between piers (short-narrow slip)
EB-6	West end of pier 54 (surface and bottom)	Center of study area-exposed conditions
EB-7	Adjacent to former wing wall at Colman Ferry Terminal	Ferry Terminal effects
EB-8	North of pier 48 (center of slip)	Between piers (long-wide slip)
EB-9	South west end of pier 48	Southern boundary of study area-exposed conditions
Current Velocity Only		
EB-1A	West end of pier 59	Northern boundary of study area- exposed conditions
EB-10	West of pier 58 (waterfront park)	Northern area outside pier face-exposed conditions
EB-11	Under pier 57	Under pier conditions-wide piling spacing
EB-12	Northeast end of pier 52 (Coleman Ferry Terminal)	Ferry Terminal effects
EB-13	Under southwest end of pier 52	Ferry Terminal effects
EB-14	Northwest end of pier 48	Southern area off pier face-exposed conditions
EB-16	West end of pier 56	Propwash effects- high frequency monitoring

Table B2: Deployment and retreival dates for Elliott Bay Sediment Traps (October 93 – October 94)

Quarter	1			2			3			4		
Station	Deployed	Retrieved	Days	Deployed	Retrieved	Days	Deployed	Retrieved	Days	Deployed	Retrieved	Days
EB1S–1A	10/20/93	1/10/94	82	1/10/94	4/11/94	91	04/11/94	07/12/94	92	7/12/94	10/10/94	90
–S1B*	10/20/93	1/10/94	82	1/10/94	4/11/94	91	04/11/94	07/12/94	92	7/12/94	10/10/94	90
–S2A*	10/20/93	1/10/94	82	1/10/94	4/11/94	91	04/11/94	07/12/94	92	7/12/94	10/10/94	90
–S2B*	10/20/93	1/10/94	82	1/10/94	4/11/94	91	04/11/94	07/12/94	92	7/12/94	10/10/94	90
EB1B–1	10/20/93	1/10/94	82	1/10/94	4/13/94	93	04/14/94	07/12/94	89	7/12/94	10/10/94	90
–B1B+	10/20/93	1/10/94	82	1/10/94	4/13/94	93	04/14/94	07/12/94	89	7/12/94	10/10/94	90
–B2A+	10/20/93	1/10/94	82	1/10/94	4/14/94	94	04/14/94	07/12/94	89	7/12/94	NR	–
–B2B+	10/20/93	1/10/94	82	1/10/94	4/14/94	94	04/14/94	07/12/94	89	7/12/94	NR	–
EB2–1A	10/13/93	NR	–	1/13/94	4/12/94	89	04/12/94	07/14/94	93	7/14/94	10/13/94	91
–1B	10/13/93	NR	–	1/13/94	4/12/94	89	04/12/94	07/14/94	93	7/14/94	10/13/94	91
–2A	10/13/93	1/13/94	92	1/13/94	4/12/94	89	04/12/94	07/14/94	93	7/14/94	10/13/94	91
–2B	10/13/93	NS	–	1/13/94	4/12/94	89	04/12/94	07/14/94	93	7/14/94	10/13/94	91
EB3–1A	10/13/93	1/12/94	91	1/12/94	NS	–	04/13/94	07/14/94	92	7/14/94	10/10/94	88
–1B	10/13/93	1/12/94	91	1/12/94	4/13/94	91	04/13/94	07/14/94	92	7/14/94	10/10/94	88
–2A	10/13/93	1/12/94	91	1/12/94	4/13/94	91	04/13/94	07/14/94	92	7/14/94	10/10/94	88
–2B	10/13/93	1/12/94	91	1/12/94	4/13/94	91	04/13/94	07/14/94	92	7/14/94	10/10/94	88
EB4–1A	10/13/93	1/13/94	92	1/13/94	4/15/94	92	04/15/94	07/13/94	89	7/13/94	10/13/94	92
–1B	10/13/93	1/13/94	92	1/13/94	NS	–	04/15/94	07/13/94	89	7/13/94	10/13/94	92
–2A	10/13/93	1/13/94	92	1/13/94	4/15/94	92	04/15/94	07/13/94	89	7/13/94	10/13/94	92
–2B	10/13/93	1/13/94	92	1/13/94	4/15/94	92	04/15/94	07/13/94	89	7/13/94	10/13/94	92
EB5–1A	10/12/93	1/11/94	91	3/02/94	4/12/94	41	04/12/94	07/11/94	90	7/11/94	10/12/94	93
–1B	10/12/93	1/11/94	91	3/02/94	4/12/94	41	04/12/94	07/11/94	90	7/11/94	10/12/94	93
–2A	10/12/93	1/11/94	91	1/11/94	4/12/94	91	04/12/94	07/11/94	90	7/11/94	10/12/94	93
–2B	10/12/93	1/11/94	91	1/11/94	4/12/94	91	04/12/94	07/11/94	90	7/11/94	10/12/94	93
EB6S–1A	10/20/93	1/11/94	83	1/11/94	NS	–	04/11/94	07/14/94	94	7/14/94	10/12/94	90
–S1B*	10/20/93	NS	–	1/11/94	4/11/94	90	04/11/94	07/14/94	94	7/14/94	10/12/94	90
–S2A*	10/20/93	NS	–	1/11/94	NS	–	04/11/94	07/14/94	94	7/14/94	10/12/94	90
–S2B*	10/20/93	NS	–	1/11/94	4/11/94	90	04/11/94	07/14/94	94	7/14/94	10/12/94	90
EB6B–1	10/20/93	1/12/94	84	1/12/94	4/13/94	91	04/13/94	07/11/94	89	7/11/94	10/11/94	92
–B1B+	10/20/93	1/12/94	84	1/12/94	4/13/94	91	04/13/94	07/11/94	89	7/11/94	10/11/94	92
–B2A+	10/20/93	1/12/94	84	1/12/94	4/13/94	91	04/13/94	07/11/94	89	7/11/94	10/11/94	92
–B2B+	10/20/93	1/12/94	84	1/12/94	4/13/94	91	04/13/94	07/11/94	89	7/11/94	10/11/94	92
EB7–1A	10/20/93	1/12/94	84	1/12/94	4/12/94	90	04/12/94	07/12/94	91	7/12/94	10/11/94	91
–1B	10/20/93	1/12/94	84	1/12/94	4/12/94	90	04/12/94	07/12/94	91	7/12/94	10/11/94	91
–2A	10/20/93	1/12/94	84	1/12/94	NS	–	04/12/94	07/12/94	91	7/12/94	NS	–
–2B	10/20/93	1/12/94	84	1/12/94	NS	–	04/12/94	07/12/94	91	7/12/94	10/11/94	91
EB8–1A	10/12/93	1/11/94	91	1/11/94	4/14/94	93	04/14/94	07/13/94	90	7/13/94	10/11/94	90
–1B	10/12/93	1/11/94	91	1/11/94	4/14/94	93	04/14/94	07/13/94	90	7/13/94	10/11/94	90
–2A	10/12/93	1/11/94	91	1/11/94	4/14/94	93	04/14/94	07/13/94	90	7/13/94	10/11/94	90
–2B	10/12/93	1/11/94	91	1/11/94	4/14/94	93	04/14/94	07/13/94	90	7/13/94	10/11/94	90
EB9–1A	10/12/93	1/10/94	90	1/10/94	4/15/94	95	04/15/94	07/13/94	89	7/13/94	10/12/94	91
–1B	10/12/93	1/10/94	90	1/10/94	4/15/94	95	04/15/94	07/13/94	89	7/13/94	10/12/94	91
–2A	10/12/93	1/10/94	90	1/10/94	4/15/94	95	04/15/94	07/13/94	89	7/13/94	10/12/94	91
–2B	10/12/93	NS	–	1/10/94	4/15/94	95	04/15/94	07/13/94	89	7/13/94	10/12/94	91

*= Surface Mooring NR= Not Recovered

+= Bottom Mooring NS= No Sample

SAMPLE
TRACKING
SHEETS

SAMPLE DATA & ANALYSIS REQUIRED

Program Code ☐☐☐

Project Code D3000

Project/Name Elliott Bay

☐ Enforcement/Custody ☐ Class II

☐ Possible Toxic/Hazardous Notes

Date Yr	Date Mo	Date Da	Time Hr	Time Mn	Field Station Identification	Lab Sample Number Wk	Lab Sample Number Seq	Matrix Code	Source Code	No. of Containers	General Chemistry: [illegible]
	07				TI-4-3	39	8573	10	40	1	✓
					TI-4-1	39	8571				✓
					TI-4-2	39	8572				✓
					TI-5A	39	8575				✓
					TI-5B	39	8576				✓
					TI-4-5	39	8577				✓
					TI-4-4	39	8574				✓

General Chemistry: Turbidity, pH, Conductivity, Total Hardness, Chloride, TS, TSS, TNVS, TNVSS, TSS, % Solids, Nutrients (4), Ammonia, Nitrate-Nitrite, Total Phosphorous, Ortho-Phosphate, BOD/5 Day, COD Chem Oxy Demand

Biology: Fecal Coliform Bacteria, Total Coliform Bacteria, Enterococcus, Fish Bioassay

Organic Chem.: Base/Neutrals/Acids, Volatile Organics, Pesticides/PCB's, PCB's Only, Purgeable Halocarbons, Herbicides, Hydrocarbon Analysis, Phenolics (AAP), Oil & Grease

METALS: P.P. Metals, EP Tox Metals, Specific List: Total ☐ Recoverable ☐ Totals ☐ Dissolved

Project Officer Dale Norton

Sampler(s) Dale Norton

Recorder Dale Norton

Date [illegible]

Chain Of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
	[illegible]	[illegible]							

ECY 040-115 Rev. 7/87

Laboratory Copy White | Project Office Copy Yellow | Field or Office Copy Pink

Particulate samples submitted for analysis January 1994 for Elliott Bay.

Station ID	Sample #	Trap #1	Station ID	Sample #	Trap #2	Station ID	Sample #	Composite Traps 1 + 2
EB1-S (Surface)			EB1-S					
1A	38230	%S	2A	38250	%S	EB1-C	38270	TOC,Metals,Semiv.,PCBs
1B	38231	%S	2B	38252	%S	EB-1SC	38279	TOC,Metals,Semiv.,PCBs
EB1-B (Bottom)			EB1-B					
1A	38232	%S	2A	38253	%S	EB1-BC	38271	TOC,Metals
1B	38233	%S	2B	38254	%S			
EB2-			EB2-					
1A	- -		2A	38255	%S,TOC,Metals	EB2-C	- -	
1B	- -		2B	- -				
EB3-			EB3-					
1A	38234	%S	2A	38256	%S	EB3-C	- -	
1B	38235	%S	2B	38257	%S			
1C	38236	TOC,Metals,Semiv,PCBs,Pb-210	2C	38258	TOC,Metals,Semiv,PCBs,Pb-210			
EB4-			EB4-					
1A	38237	%S	2A	38259	%S	EB4-C	38272	TOC,Metals,(Semiv.,PCBs).Pb-210
1B	38238	%S	2B	38260	%S	EB4-CD(du	38273	TOC,Metals,Semiv.,PCBs.Pb-210
EB5-			EB5-					
1A	38239	%S	2A	38261	%S	EB5-C	38274	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	38240	%S	2B	38262	%S			
EB6-S (Surface)			EB6-S					
1A	38241	%S,Metals	2A	- -		EB6-SC	- -	
1B	- -		2B	- -				
EB6-B (Bottom)			EB6-B					
1A	38242	%S	2A	38263	%S	EB6-BC	38275	TOC,Metals,Semiv.,PCBs.Pb-210
1B	38243	%S	2B	38264	%S			
EB7-			EB7-					
1A	38244	%S	2A	38265	%S	EB7-C	38276	TOC,Metals,Semiv.,PCBs.Pb-210
1B	38245	%S	2B	38266	%S			
EB8-			EB8-					
1A	38246	%S,TOC	2A	38267	%S	EB8-C	38277	Metals,Semiv.,PCBs.Pb-210
1B	38247	%S	2B	38268	%S			
EB9-			EB9-					
1A	38248	%S	2A	38269	%S	EB9-C	38278	TOC,Metals,Semiv.,PCBs.Pb-210
1B	38249	%S	2B	- -				

( )=Fraction lost in extraction
GS-Grain Size Seive and pipet portion only
-No sample
Metals (11)=Al,As,Cd,Cr,Cu,Fe,Pb,Mn,Hg,Ag,Zn)

Reference Materials
HS-6 (PAH) NRCC in duplicate
HS-2 (PCBs) NRCC in duplicate
#1646 (Metals) NIST in duplicate
EPA LCS (Metals) in duplicate

Notes:
EB1-C= Composite of surface and bottom samples
EB1-1SC= Samples 2A and 2B used in composite
EB1-BC= Samples 2A and 2B used in composite
EB5-2A= Not used in overall composite

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination

ID: D3C00

Send Results to: Dale Norton Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by 3/7/94

TOP 10 Peaks

Sampling Date Year: 4

Da	Hr	Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Metals (11) ② / Pb-210	BNA	PCB's only
21			EB-1S1A	38230	40	42	1	✓			
			EB-1S1B	8231			1	✓			
			EB-1S2A	8250			1	✓			
			-1S2B	8252			1	✓			
			EB-1C	8270			3	✓	✓	✓	✓
			EB-1SC	8279			3	✓	✓	✓	✓
			EB-1B1A	8232			1	✓			
			-1B1B	8233			1	✓			
			-1B2A	8253			1	✓			
			-1B2B	8254			1	✓			
			EB-1BC	8271			2	✓	✓		
			EB-2S1A	8295			3	✓	✓		

General Chemistry: Grain Size ①

Metals: ☒ Total ☐ Total Rec

Organic Chemistry: BNA ☒ CLP TIC's

Field Officer: Dale Norton

Phone number: 407-6765

Samplers: Norton, Dale; [illegible], Dave

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	01	21	16	00			
	Pam Covey	94	01	24	09	40			

Comments: ① Grain Size = Abramate using [illegible] seive + pipet portion BNA - TOP 10 TIC'S
② Metals (11) = Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ag and Zn
Analysis to be conducted per Sampling + Analysis Plan Specs.
Ref. Materials = HS-6 (PAH), HS-2 ([illegible]), 1646 (metals) and EPA LCS (metals) all materials analyzed in duplicate

Sampler: Norton 1/21/94

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Project Name: Elliott Bay Recontamination

LABORATORY ANALYSES REQUIRED

PIC: D3C00

Send Results to: Dale Norton **Mail Stop:** 7710

☐ Preliminary investigation ☒ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by: 3/7/94

Date (Year: 94) Mo/Da	Time Hr/Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry: %Solids / TOC	Metals (Total): Metals (11)	Metals: Pb-210	Organic Chemistry: BNA (CLP TIC's)	Organic Chemistry: PCB's only
01/21		EB-31A	38234	40	42	1	✓				
		-31B	38235			1	✓				
		-31C	8236			4	✓	✓	✓	✓	✓
		-32A	8256			1	✓				
		-32B	8257			1	✓				
		-32C	8258			4	✓	✓	✓	✓	✓
		EB-41A	8237			1	✓				
		-41B	8238			1	✓				
		-42A	8259			1	✓				
		-42B	8260			1	✓				
		-4C	8272			4	✓	✓	✓	✓	✓
		-4CD	8273			4	✓	✓	✓	✓	✓

Printed analysis columns: General Chemistry — Alkalinity, Conductivity, Hardness, pH, Turbidity, ☐ Chloride ☐ Sulfate, Cyanide ☐ Total ☐ Weak, Total Solids, Total Nonvolatile Solids, Total Suspended Solids, Total Nonvol Suspend, Total Dissolved Solids, %Solids, TOC, BOD-(5 day), Oil & Grease, Ammonia, Nitrate-Nitrite, Total Phosphorous, Orthophosphorous, Nitrate, Nitrite, ☐ TPN ☐ TKN, Grain Size; Micro — Fecal Coliforms ☐ MF ☐ MPN, Total Coliforms, E-Coli, %Klebsiella; Biology — Ceriodaphnia, D magna, D pulex, Fathead minnow, Microtox, Salmonid, Salmonid Haz Waste; Metals — ☒ Total ☐ Total Rec, ICP Scan, PP Metals, TCLP Metals, Cd Cr Cu Ni Pb Zn, Mercury (Hg), Metals (11), Pb-210; Organic Chemistry — BNA ☒ CLP TIC's ☐ No TIC's, BNA w/ extensive TIC's, PAH's, VOA ☐ CLP TIC's ☐ No TIC's, VOA w/ extensive TIC's, BTEX, Organo Chlorine Pests/PCB's, PCB's only, Organophosphorous Pests, Chlorophenoxy Herbs, WTPH-HCID, WTPH-G, WTPH-D, WTPH-418.1 Modified, AED screen.

Project Officer: Dale Norton
Scan number: 407-6765
Samplers: Dale Norton, Dave Serdar

Recorder: Norton
Date: 1/21/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	01	21					
	Jan Cellery	94	01	21	09	00			

Comments: See page 1 BNA - Top 10 TIC'S

LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination

D3C00

Results to: Dale Norton Mail Stop: 7710

☒ Preliminary Investigation ☐ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by 3/7/94

Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	Analyses checked
EB-51A	38239	40	42	1	✓ (General Chemistry)
-51B	38240			1	✓ (General Chemistry)
-52A	38261			1	✓ (General Chemistry)
-52B	38262				✓ (General Chemistry)
-5C	38274			5	✓ (General Chemistry); ✓ Grain Size; ✓ Metals (1); ✓ Pb-210; ✓ BNA; ✓ PCB's only
EB-6S1A	382[illegible]				✓ Pb-210
EB-6B1A	18242			1	✓ (General Chemistry)
-6B1B	[illegible]				✓ (General Chemistry)
-6B2A	18263			1	✓ (General Chemistry)
-6B2B	8264				✓ (General Chemistry)
-6BC	8275			4	✓ (General Chemistry); ✓ Metals (1); ✓ Pb-210; ✓ BNA; ✓ PCB's only
[illegible]	[illegible]				✓ (General Chemistry)

Metals: ☒ Total ☐ Total Rec

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Norton

Date: 1/21/94

Chain of Custody Record

Relinquished By	Received By	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	01	21					
	Pam Cure	94	01	24	09	00			

Comments: See page 1

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LABORATORY ANALYSES REQUIRED

Project Name: Eliott Bay Recontamination
D3C00
Results to: Norton   Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by 3/7/94

Time Hr	Time Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry: TOC	General Chemistry: Grain Size	Metals (11)	Pb-210	BNA	PCB's only
		EB-71B	38245	40	42	1	✓					
		-72A	8265	"	"	1	✓					
		-72B	8266	"	"	1	✓					
		-7C	8276	"	"	1	✓					
		EB-81A	8246	"	"	2	✓		✓	✓	✓	✓
		-81B	8247	"	"	1	✓					
		-82A	8267	"	"	1	✓					
		-82B	8268	"	"	1	✓					
		-8C	8277	"	"	3	✓		✓	✓	✓	✓
		EB-91A	8248	"	"	1	✓					
		-91B	8249	"	"	1	✓					
		-92A	8269	"	"	1	✓					

Project Officer: Dale Norton
Scan number: 407-6765
Samplers: Dale Norton, Dave Serdar

Recorder: Norton
Date: 1/21/94

Chain of Custody Record

Relinquished By:	Received By:	Yr.	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	01	21					
	Pam Covey	94	01	24	09	00			

Comments: See page 1.

ECY 040-115 Rev. 12/93

LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination

13C00

Results to: D. Norton   Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by 3/7/94

Sampling Date (Da)	Time (Hr)	Time (Mn)	Field Station Identification	Lab Sample Number	Matrix Code / Source Code / No. of Containers	Metals (☒ Total)	Organic Chemistry
21			EB-9C	38278	[illegible]	✓ Pb-210; ✓ [illegible]	✓ BNA (☒ CLP TIC's); ✓ Organo Chlorine Pests/PCBs (PCB's only)

Form analysis columns: General Chemistry: Alkalinity, Conductivity, Hardness, pH, Turbidity, ☐ Chloride ☐ Sulfate, Cyanide ☐ Total ☐ Weak, Total Solids, Total Nonvolatile Solids, Total Suspended Solids, Oil & Grease, Ammonia, Nitrate-Nitrite, ☐ TPN ☐ TKN. Micro: Fecal Coliforms, Total Coliforms, E-Coli, %Klebsiella. Biology: Ceriodaphnia, D magna, D pulex, Echinoid, Salmonid, Salmonid Haz Waste. Metals: ICP Scan, PP Metals, TCLP Metals, Cd Cr Cu Ni Pb Zn, Mercury (Hg), ☒ Total ☐ Total Rec. Organic Chemistry: BNA ☒ CLP TIC's ☐ No TIC's, BNA w/ extensive TIC's, PAH's, VOA ☐ CLP TIC's ☐ No TICs, VOA w/ extensive TIC's, BTEX, Organo Chlorine Pests/PCBs (PCB's only), Organophosphorous Pests, Chlorophenoxy Herbs, WTPH-HCID, WTPH-G, WTPH-D, WTPH-418.1 Modified, AED screen.

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Norton 1/21/94

Chain of Custody Record

Relinquished By	Received By	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	01	21					
	Perry Civey	94	01	24	09	00			

Comments: See page 1

Sam₁ [circle] ubmitted for analysis April 1994 (2nd quarter) for Elliott Waterfront Recontamination Study.

Station ID	Sample#	Trap #1	Station ID	Sample#	Trap #2	Station ID	Sample#	Composite Traps 1 +2
EB1-S (Surface)			EB1-S					
1A	168400	%S	2A	168402	%S	EB-1SOC	168404	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168401	%S	2B	168403	%S			
EB1-B (Bottom)			EB1-B					
1A	168405	%S	2A	168407	%S	EB1-BOC	168409	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168406	%S	2B	168408	%S			
EB2-			EB2-					
1A	168410	%S	2A	168412	%S	EB2-OC	168414	TOC,Metals,Semiv.,Pb-210,GS
1B	168411	%S	2B	168413	%S	EB2-OCD	168415	TOC,Metals,Semiv.,Pb-210,GS
EB3-			EB3-					
1A	- -		2A	168417	%S	EB3-OC	168419	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168416	%S	2B	168418	%S			
EB4-			EB4-					
1A	168420	%S	2A	168421	%S	EB4-OC	168423	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	- -		2B	168422	%S			
EB5-			EB5-					
1A	168424	%S	2A	168426	%S	EB5-OC	168428	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168425	%S	2B	168427	%S			
EB6-S (Surface)			EB6-S					
1A	- -		2A	- -		EB6-SOC	168431	TOC,Metals,Semiv.
1B	168429	%S	2B	168430	%S			
EB6-B (Bottom)			EB6-B					
1A	168432	%S	2A	168434	%S	EB6-BOC	168436	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168433	%S	2B	168435	%S			
EB7-			EB7-					
1A	168437	%S	2A	- -		EB7-OC	- -	
1B	168438	%S	2B	- -				
1C	168439	TOC,Metals,Semiv.,Pb-210,GS						
EB8-			EB8-					
1A	168440	%S(dup)-168441	2A	168443	%S	EB8-OC	168445	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168442	%S	2B	168444	%S			
EB9-			EB9-					
1A	168446	%S	2A	168448	%S	EB9-OC	168450	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	168447	%S	2B	168449	%S			

GS-Grain Size Seive and pipet portion only
Metals (11)=Al,As,Cd,Cr,Cu,Fe,Pb,Mn,Hg,Ag,Zn)

<u>Reference Materials</u>
HS-6 (PAH) NRCC in duplicate
HS-2 (PCBs) NRCC in duplicate
#1646 (Metals) NIST in duplicate
EPA LCS (Metals) in duplicate

Minimum Sample Volumes (wet grams)	
%S	5-10
Grain Size	10-20
TOC	5-10
Metals	10-15
Semivolatiles	20-25
PCBs	20-25
Pb-210	10-15
Total=	80-120

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Project Name: Elliott Bay WF Recontamination

LABORATORY ANALYSES REQUIRED

Page 1 of

PIC: D3C00

Send Results to: Dale Norton **Mail Stop:** 47710

☐ Preliminary Investigation ☒ Monitoring ☒ For HW Designation ☐ For NPDES

Results needed by: 45 days (6/6/94)

Year: 94

Mo	Da	Hr	Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	Total Solids (%)	Grain Size	Metals	Organics
04	20			EBIS-1A	168400	40	40	1	✓			
				-1B	8401			1	✓			
				-2A	8402			1	✓			
				-2B	8403			1	✓			
				EBIS0C	8404			6	✓	✓	✓ ✓	✓ ✓
				EBIB-1A	8405			1	✓			
				-1B	8406			1	✓			
				-2A	8407			1	✓			
				-2B	8408			1	✓			
				EBIB0C	8409			6	✓	✓	✓ ✓	✓ ✓
				EB2-1A	8410			1	✓			
				-1B	8411			1	✓			

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Dale Norton

Date: 4/2[illegible]

Chain of Custody Record

Relinquished By:	Received By:	Yr Mo Da Hr Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		9404201500			
	Pam Covey	940421 [illegible]			

Comments: See Attached Sheet for list of metals + QA info. Grain Size – Abbreviate if necessary to Sieve + Pipet only

Project Name: Elliott Bay WF Recontamination **LABORATORY ANALYSES REQUIRED** Page 2 of 5

03C00

Results to: Dale Norton Mail Stop: 47710

☒ Preliminary Investigation ☒ Monitoring ☒ For HW Designation ☐ For NPDES

Results needed by 45 days (6/6/94)

Sampling Mo/Da	Time Hr/Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Grain Size	Metals (11)	Pb-210	BNA (CLP TIC's)	PCB's only
4/20		EB2-2A	168412	45								
		-2B	8413									
		EB2-2C	8414			5	✓	✓	✓	✓	✓	
		EB2-2D	8415				✓	✓	✓	✓	✓	
		EB3-1B	8416			1	✓					
		-2A	8417			1	✓					
		-2B	8418			1	✓					
		EB3-2C	8419			6	✓	✓	✓	✓	✓	✓
		EB4-1A	8420			1	✓					
		-2A	8421				✓					
		-2B	8422			1	✓					
		EB4-2C	8423			6	✓	✓	✓	✓	✓	✓

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Dale Norton

Date: 4/20/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	04	20	15	00			
	Sam Cross	94	04	21	09	00			

Comments: See attached sheet for list of metals + QA Info. Grain Size Abreviate to Sieve + pipet only if necessary

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay, WE [illegible]

TIC: D3C00

Send Results to: Dale Norton Mail Stop: 47710

☐ Preliminary Investigation ☒ Monitoring ☒ For HW Designation ☐ For NPDES

Results needed by 45 days (6/6/94

Mo/Da	Field Station Identification	Lab Sample Number	Matrix Code	No. of Containers	General Chemistry	Grain Size	Metals(1) (Total)	Pb-210	BNA (CLP TIC's)	PCB's only
4/20	EB5-1A	168424	40	1						
	-1B	8425		1						
	-2A	8426		1						
	-2B	8427		1						
	EB5CC	8428		6	✓	✓	✓	✓	✓	✓
	EB6S-1B	8429		1						
	-2B	8430		1	✓					
	EB6SCC	8431		3	✓		✓		✓	
	EB6B-1A	8432		1	✓					
	-1B	8433		1	✓					
	-2A	8434		1	✓					
	-2B	8435		1	✓					

Year: 94

Project Officer: Dale Norton
Phone number: 407-6765
Samplers: Dale Norton, Dave Serdar
Recorder: Dale Norton
Date: 4/20/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	04	20	15	00			
	Jim Carey	94	04	21	09	00			

Comments: See attached sheet for list of metals & QA [illegible]. Analyze grain size to [illegible] pipet only if necessary

[illegible] 115 Rev. 12/93

LABORATORY ANALYSES REQUIRED

Project Name: [illegible] Bay WF [illegible]

PIC: D3C00

Send Results to: Dale Norton   Mail Stop: 47710

Preliminary Investigation ☒ Monitoring

☒ For HW Designation ☐ For NPDES

Results needed by 45 days (6/6/94)

Year: 94

Mo	Da	Field Station Identification	Lab Sample Number	No. of Containers	TOC	Grain Size	Metals(11) Total	Pb-210	BNA (CLP TIC's)	PCB's only
4	20	EB6BOC	168436	6	✓	✓	✓	✓	✓	✓
		EB7-1A	8437	1	✓					
		-1B	8438	1	✓					
		-1C	8439	5	✓	✓	✓	✓	✓	
		EB8-1A	8440	1	✓					
		-1AD	8441	1	✓					
		-1B	8442	1	✓					
		-2A	8443	1	✓					
		-2B	8444	1	✓					
		EB8OC	8445	6	✓	✓	✓	✓	✓	✓
		EB9-1A	8446	1	✓					
		-1B	8447	1	✓					

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Dale Norton

Date: 4/20/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn
Dale Norton		94	04	20		
	Pam Covey	94	04	21	08	00

Comments: See attached sheet for list of metals & QA info. Analyze Grain Size to Sieve + pipet only if necessary

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay WF Recontamination

PIC: D3C00

Send Results to: Dale Norton Mail Stop: 47710

☐ Preliminary Investigation ☒ Monitoring ☐ For HW Designation ☐ For NPDES

Results needed by 45 days (6/6/94)

General Chemistry: Alkalinity, Conductivity, Hardness, pH, Turbidity, ☐ Chloride ☐ Sulfate, Cyanide ☐ Total ☐ Weak, Total Solids, Total Nonvolatile Solids, Total Suspended Solids, Total Nonvol Suspend, Total Dissolved Solids, % Solids/% Vol. Solids, TOC, BOD, COD, Oil & Grease, Ammonia, Nitrate-Nitrite, Total Phosphorous, Orthophosphate, Nitrite, Nitrate, ☐ TPN ☐ TKN, Grain Size

Micro: Fecal Coliforms ☐ MF ☐ MPN, Total Coliforms, E-Coli, %Klebsiella

Biology: Ceriodaphnia ☐ acute ☐ chron, D.magna ☐ acute ☐ chron, D.pulex ☐ acute ☐ chron, Fathead minnow, Microtox, Salmonid, Salmonid Haz Waste

Metals: ☒ Total ☐ Total Rec; ICP Scan, PP Metals, TCLP Metals, Cd Cr Cu Ni Pb Zn, Mercury (Hg), Metals(11), Pb-210

Organic Chemistry: BNA ☒ CLP TIC's ☐ No TIC's, BNA w/ extensive TIC's, PAH's, VOA ☐ CLP TIC's ☐ No TIC's, VOA w/ extensive TIC's, BTEX, Organo Chlorine Pests/PCB's, PCB's only, Organophosphorous Pests, Chlorophenoxy Herbs, WTPH-HCID, WTPH-G, WTPH-D, WTPH-418.1 Modified, AED screen

Date	Time (Hr, Mn)	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	TOC	Grain Size	Metals(11)	Pb-210	BNA	PCB's only
		EB9-2A	168448	40	40	1	✓					
		-2B	84449			1						
		EB90C	84450			6		✓	✓	✓	✓	✓

Project Officer: Dale Norton

Phone number: 407-6765

Samplers: Dale Norton, Dave Serdar

Recorder: Dale Norton 4/20/94

Chain of Custody Record

Relinquished By:	Received By:	Yr.	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	04	20	15	00			
	Pam Covey	94	04	21	07	00			

Comments: See attached sheet for list of metals & QA info. Abbreviate Grain Size to seive + piplet only if necessary

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LABORATORY ANALYSES REQUIRED

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Project Name: Elliott Bay Recontamination

D3C00

Send Results to: Dale Norton   Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring

☐ For HW Designation ☐ For NPDES

Results needed by 8/12/94

Date Da	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	Pb-210 (Radio-chemistry)	Cs-137 (Radio-chemistry)
24	C1-1	268500	42	40	1	✓	✓
	C1-3	8501			1	✓	✓
	C1-5	8502			1	✓	✓
	C1-7	8503			1	✓	✓
	C1-9	8504			1	✓	✓
	C1-11	8505			1	✓	✓
	C1-13	8506			1	✓	✓
	C1-15	8507			1	✓	✓
	C1-17	8508			1	✓	✓
	C1-19	8509			1	✓	✓
	C1-21	8510			1	✓	✓
	C1-22	8511			[illegible]	✓	✓

Project Officer: Dale Norton

Phone Number: 407-6765

Samplers: Dale Norton, Bob Barnard, Laura Weiss

Recorder: Dale Norton 6/25/94

Chain of Custody Record

Relinquished By	Received By	Yr Mo Da Hr Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		9406281500			
	Sam McCully	9406291320			

Comments: Pb-210 and Cs-137 per previous contract w/ Battelle Sequim

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination
PIC: D3C00
Send Results to: Dale Norton Mail Stop: 7710

☒ Preliminary Investigation
☒ Monitoring
☐ For HW Designation
☐ For NPDES

Results needed by 8/12/94

Date (Da)	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	%Solids	Grain Size	Pb-210	Cs-137 / dating	Metals ☒ Total: Metals(7)	Organo Chlorine Pests/PCB's
24	C1-A	268512	42	40	4	✓	✓			✓	✓
	C1-B	8513			2					✓	✓
	C1-C	8514			2					✓	✓
	C1-D	8515			2					✓	✓
	C1-E	8516			2					✓	✓
	C1-F	8517			2					✓	✓
	C2-1	8518			1	✓		✓	✓		
	C2-3	8519			1	✓		✓	✓		
	C2-5	8520			1	✓		✓	✓		
	C2-7	8521			1	✓		✓	✓		
	C2-9	8522			1	✓		✓	✓		
	C2-11	8523			1	✓		✓	✓		

Project Officer: Dale Norton
Phone number: 407-6765
Samplers: Dale Norton, B. Barnard, L. Weiss

Recorder: Dale Norton
Date: 6/28/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	06	28	15	00			
	Jim Cure	94	06	29	13	20			

Comments: Metals(7) = Al, Cu, Fe, Pb, Mg, Hg, Zn - per previous sample set. See Sampling & Analysis plan. Dating - B. Hills, Battelle. Grain Size - PSEP method. Alternate to sieve & pipet if insufficient volume.

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination
PIC: D3C00
Send Results to: Dale Norton Mail Stop: 7710

☐ Preliminary Investigation
☒ Monitoring
☐ For HW Designation
☐ For NPDES

Results needed by 8/12/94

Metals: ☒ Total ☐ Total Rec

Date	Time	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	TOC	Pb-210	Cs-137	Grain Size	Metals (7)	PCB's only
		C2-13	268524	42	40	1	✓	✓	✓			
		C2-15	8525			1	✓	✓	✓			
		C2-17	8526			1	✓	✓				
		C2-19	8527			1	✓	✓				
		C2-21	8528			1	✓	✓				
		C2-23	8529			1	✓	✓				
		C2-25	8530			1	✓	✓				
		C2-A	8531			2	✓			✓	✓	✓
		C2-B	8532			2					✓	✓
		C2-C	8533			2					✓	✓
		C2-D	8534			2					✓	✓
		C2-E	8535			2					✓	✓

Project Officer: Dale Norton
Scan number: 407-6765
Samplers: Dale Norton, B. Barnard, L. Weiss
Recorder: Dale Norton
Date: 6/28/94

Chain of Custody Record

Relinquished By:	Received By:	Yr Mo Da	Hr Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		940628	1500			
	Pam Covey	940629	1320			

Comments: See notes on Sheet #2

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LABORATORY ANALYSES REQUIRED

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Project Name: Elliott Bay Recontamination

D3C00

Send Results to: Dale Norton Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring ☐ For HW Designation ☒ For NPDES

Results needed by 8/12/94

Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Pb-210	Cs-137	Grain Size	Metals (7) (☒ Total)	PCB's only
C2-F	268536	41	24	2					✓	✓
C3-1	8537			1	✓	✓	✓			
C3-3	8538			1	✓	✓	✓			
C3-5	8539			1	✓	✓	✓			
C3-7	8540			1	✓	✓	✓			
C3-9	8541			1	✓	✓	✓			
C3-11	8542			1	✓	✓	✓			
C3-13	8543			1	✓	✓	✓			
C3-15	8544			1	✓	✓	✓			
C3-17	8545			1	✓	✓	[illegible]			
C3-19	8546			1	✓	✓				
C3-21	8547			[illegible]	✓	✓	[illegible]			

Project Officer: Dale Norton

Scan number: 2107-6765

Samplers: Dale Norton, B. Barnard, L. Weiss

Recorder: Dale Norton

Date: 6/28/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Dy	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	06	29	15	00			
	Pam Covey	94	06	29	13	20			

Comments: See notes on Page 2

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination 03C00

Results to: Dale Norton   Mail Stop: 7710

☐ Preliminary Investigation ☒ Monitoring   ☐ For HW Designation ☐ For NPDES

Results needed by 8/12/94

Sampling Time (Hr Mn)	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Pb-210/Cs-137 dating	Grain Size	Metals: Metals (7) (☒ Total)	Organic Chemistry
	03-23	268548	42	40	1	✓	✓			
	03-25	8549					✓			
	03-A	8550				✓		✓	✓	✓
	03-B	8551							✓	✓
	03-C	8552			2				✓	✓
	03-D	8553							✓	✓
	03-E	8554			2				✓	✓
	03-F	8555							✓	✓
	03-G	8556			2				✓	✓
	03-H	8557							✓	✓
	03-AD	8558			2	✓		✓		
	03-CD	8559							✓	✓

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, B. Bernard, L. Weiss

Recorder: Dale Norton

Date: 6/28/94

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	06	28	15	00			
	Pam Covey	94	06	29	13	20			

Comments: See Page #2 for Note.

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination

23C00

Results to: Dale Norton Mail Stop: [illegible]

Preliminary Investigation / Monitoring

☐ For HW Designation
☐ For NPDES

Results needed by 8/12/94

Sampling Date Mo	Da	Time Hr	Mn	Field Station Identification	Lab Sample Number	No. of Containers	General Chemistry	Micro	Biology	Metals	Organic Chemistry
	24			C3-9D	268560 [illegible]	1	CS-B7 / 26-2K / dolin				
	↓			C3-5D	[illegible]	1	✓				

Year: 95

Metals: ☐ Total ☐ Total Rec; ICP Scan; PP Metals; TCLP Metals; Cd Cr Cu Ni Pb Zn; Mercury (Hg)

Micro: Fecal Coliforms ☐ MF ☐ MPN; Total Coliforms; E-Coli; %Klebsiella

Organic Chemistry: BNA ☐ CLP TIC's ☐ No TIC's; BNA w/ extensive TIC's; PAH's; VOA ☐ CLP TIC's ☐ No TIC's; VOA w/ extensive TIC's; BTEX; Organo Chlorine Pesticides; PCB's only; Organophosphorus Pests; Chlorophenoxy Herbs; WTPH-HCID; WTPH-G; WTPH-D; WTPH-418.1 Modified; AED screen

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, B. Barnard, L. Weiss

Chain of Custody Record

Relinquished By	Received By	Yr Mo Da Hr Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		940628/1500			
	Pam Covey	940629/1324			

Comments: See notes on page #2

Recorder: Dale Norton 6/28/94

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Sampl ubmitted for analysis July 1994 (3rd quarter) for Elliott Bay Waterfront Recontamination Study.

Station I	Sample#	Trap #1	Station ID	Sample#	Trap #2	Station ID	Sample#	Composite Traps 1 + 2
EB1-S (Surface)			EB1-S					
1A	298500	%S	2A	298502	%S	EB-1SOC	298504	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298501	%S	2B	298503	%S			
EB1-B (Bottom)			EB1-B					
1A	298505	%S	2A	298507	%S	EB1-BOC	298509	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298506	%S	2B	298508	%S			
EB2-			EB2-					
1A	298510	%S	2A	298512	%S	EB2-OC	298514	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298511	%S	2B	298513	%S			
EB3-			EB3-					
1A	298515	%S	2A	298517	%S	EB3-OC	298519	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298516	%S	2B	298518	%S			
EB4-			EB4-					
1A	298520	%S	2A	298522	%S	EB4-OC	298524	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298521	%S	2B	298523	%S	EB4-OCD	298525	TOC,Metals,Semiv.,PCBs.Pb-210,GS
EB5-			EB5-					
1A	298526	%S	2A	298528	%S	EB5-OC	298530	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298527	%S	2B	298529	%S			
EB6-S (Surface)			EB6-S					
1A	298531	%S	2A	298533	%S	EB6-SOC	298535	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298532	%S	2B	298534	%S			
EB6-B (Bottom)			EB6-B					
1A	298536	%S	2A	298538	%S	EB6-BOC	298540	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298537	%S	2B	298539	%S			
EB7-			EB7-					
1A	298541	%S	2A	298544	%S	EB7-OC	-	-
1B	298542	%S	2B	298545	%S			
1C	298543	TOC,Metals,Semiv.,PCBs.Pb-210,GS	2C	298546	TOC,Metals,Semiv.,PCBs.Pb-210,GS			
EB8-			EB8-					
1A	298547	%S(dup)-298548	2A	298550	%S	EB8-OC	298552	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298549	%S	2B	298551	%S			
EB9-			EB9-					
1A	298553	%S	2A	298555	%S	EB9-OC	298557	TOC,Metals,Semiv.,PCBs.Pb-210,GS
1B	298554	%S	2B	298556	%S			

GS-Grain Size Seive and pipet portion only
Metals (11)=Al,As,Cd,Cr,Cu,Fe,Pb,Mn,Hg,Ag,Zn)

<u>Reference Materials</u>
HS-6 (PAH) NRCC in duplicate
HS-2 (PCBs) NRCC in duplicate
#1646 (Metals) NIST in duplicate

<u>Minimum Sample Volumes (wet grams)</u>	
%S	5-10
Grain Size	10-20
TOC	5-10
Metals	10-15
Semivolatiles	20-25
PCBs	20-25
Pb-210	<u>10-15</u>
Total=	80-120

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay [illegible]

PIC: D3C00

Send Results to: Dale Norton Mail Stop: [illegible]

☐ For HW Designation
☐ For NPDES

Results needed by 9/7/94 (45 days)

Date Year: 94 Da	Time Hr	Time Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Grain Size	Pb-210	Metals (Total) Metals(11)	BNA	Organic Chemistry (Pests/PCB's)
20			EB15-1A	298500	[illegible]	[illegible]	1	✓					
			-1B	8501			1	✓					
			-2A	8502			1	✓					
			-2B	8503				✓					
			EB15-0C	8504			6	✓	✓	✓	✓	✓	✓
			EB18-1A	8505				✓					
			-1B	8506			1	✓					
			-2A	8507			1	✓					
			-2B	8508			1	✓					
			EB18-0C	8509			6	✓	✓	✓	✓	✓	✓
			EB2-1A	8510			1	✓					
			-1B	8511			1	✓					

Project Officer: Dale Norton
Phone number: 407-6765
Samplers: Dale Norton
Dave Serdar
Rob Bernard

Recorder: Dale Norton
Date: 7/20/94

Chain of Custody Record

Relinquished By:	Received By:	Yr. Mo Da Hr Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94 07 20 15 00			
	Pam Covey	94 07 21 1 30			

Comments: Metals(11) = Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ag and Zn
Reference materials c HS-2, HS-6 and NIST 1646 in duplicate
Battelle Sequim doing Pb-210

LABORATORY ANALYSES REQUIRED

Project Name: [illegible] Bay Reconnaissance
PIC: D3C00
Send Results to: Dale Norton   Mail Stop: 7710

☒ Preliminary Investigation   ☐ For HW Designation
☒ Monitoring   ☐ For NPDES

Results needed by 9/7/94

Metals: ☒ Total ☐ Total Rec

Year: 94

Da	Hr	Mn	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers	General Chemistry	Grain Size	Pb-210	Metals m-6/5(11)	BNA (CLP TIC's)	Organic Chemistry
20			EB2-2A	298512	40	42	1	✓					
			-2B	8513			1	✓					
			EB2-0C	8514			6	✓	✓	✓	✓	✓	✓
			EB3-1A	8515			1	✓					
			-1B	8516			1	✓					
			-2A	8517			1	✓					
			-2B	8518			1	✓					
			EB3-0C	8519			6	✓	✓	✓	✓	✓	✓
			EB4-1A	8520			1	✓					
			-1B	8521			1	✓					
			-2A	8522			1	✓					
			-2B	8523			1	✓					

Project Officer: Dale Norton
Scan number: 407-6765
Samplers: Dale Norton, Dave Serdar, Bob Barnard

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	07	20	15	00			
	Pam Covey	94	07	21	11	30			

Comments: See page 1

[illegible]: Dale Norton
7/20/94

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LABORATORY ANALYSES REQUIRED

Project Name: Elliott Bay Recontamination

ID: D3C00

Send Results to: Dale Norton Mail Stop: 7710

☐ Preliminary Investigation ☐ Monitoring ☒ For HW Designation ☐ For NPDES

Results needed by 9/7/94

Date	Time (Hr, Mn)	Field Station Identification	Lab Sample Number	Matrix Code	Source Code	No. of Containers
		EB8-1AD	298548	40	40	1
		-1B	8549			1
		-2A	8550			1
		-2B	[illegible]			[illegible]
		EB8-0C	[illegible]			[illegible]
		EB9-1A	[illegible]			[illegible]
		-1B	[illegible]			[illegible]
		-2A	[illegible]			[illegible]
		-2B	8556			1
		EB9-0C	8557			[illegible]

Analysis columns: General Chemistry (Alkalinity, Conductivity, Hardness, pH, Turbidity, ☐ Chloride ☐ Sulfate, Cyanide ☐ Total ☐ Weak, Total Solids, Total Nonvolatile Solids, Total Suspended Solids, …, BOD (5 day), Oil & Grease, Ammonia, …, Nitrate, Nitrite, ☐ TPN ☐ TKN, Grain Size, Pb-210); Micro (Fecal Coliforms ☐ MF ☐ MPN, Total Coliforms, E-Coli, %Klebsiella); Biology (Ceriodaphnia ☐ acute ☐ chron, D.magna ☐ acute ☐ chron, D.pulex ☐ acute ☐ chron, Fathead minnow, Microtox, Salmonid, Salmonid-Haz Waste); Metals (☐ Total ☐ Total Rec; ICP Scan, PP Metals, TCLP Metals, Cd Cr Cu Ni Pb Zn, Mercury (Hg), Metals (11)); Organic Chemistry (BNA ☒ CLP TIC's ☐ No TIC's, BNA w/ extensive TIC's, PAH's, VOA ☐ CLP TIC's ☐ No TIC's, VOA w/ extensive TIC's, BTEX, Organo Chlorine Pests/PCB's, PCB's only, Organophosphorous Pests, Chlorophenoxy Herbs, WTPH-HCID, WTPH-G, WTPH-D, WTPH-418.1 Modified, AED screen)

Project Officer: Dale Norton

Scan number: 407-6765

Samplers: Dale Norton, Dave Serdar, Bob Barnard

Recorder: Dale Norton

Date: 7/20/94

Chain of Custody Record

Relinquished By	Received By	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments
Dale Norton		94	07	20	15	00			
	Pam Covey	94	07	21	11	30			

Comments: See page 1

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